Popular Astronomy.

Vol. XXXVI, No. 7 AUGUST-SEPTEMBER, 1928 Whole No. 357

FRANK W. VERY.

By J. GORDON OGDEN.

Frank Washington Very, the eminent astronomer, astrophysicist, and meteorologist, who died November 23, 1927, was born in Salem, Massachusetts, in 1852. His early education was received in the Salem public schools, whence he graduated from the High School in 1869. He entered the newly chartered Massachusetts Institute of Technology where he planned to prepare himself for chemical engineering. He was graduated in 1873 with the degree of Bachelor of Science. Owing to the fact that he lost his sense of smell, he gave up the career that he had outlined, and turned his attention to Astronomy and Physics. It is interesting to note that the loss of one of his senses was more than compensated by his extraordinary eyesight. His retina was especially sensitive to the upper end of the spectrum.

Upon his graduation, he remained with his *alma mater* in the capacity of instructor in Physics. In 1878, he was called to the Allegheny Observatory as assistant astronomer to Dr. Samuel P. Langley. In 1890 he was elected to the chair of Astronomy in the Western University of Pittsburgh, retaining this position until 1895. For the next two years he was the Director of the Ladd Observatory at Brown University. Then followed a period of independent research in astronomy, astrophysics, and meteorology, which resulted in the publication of a number of important papers. Among other investigations he made a study of X-Rays with a view to their application as a medicinal factor. He collaborated with Professor Reginald Fessenden in experiments in Wireless Telegraphy. He assisted Frank W. Bigelow in the preparation of his books on the thermodynamics of the atmosphere. Also, at this time he was requested by the United States Weather Bureau to develop a system of radio signals by means of which vessels at sea might be communicated with. This was the beginning of ship-to-ship, and ship-to-shore communication.

In 1906, Very had the good fortune to meet Professor Percival Lowell. This connection is best described by a quotation from a letter to the writer from Alice Very Brown, eldest daughter of Very.

"Here was a brother scientist with whose views Professor Very was in complete sympathy; a man of great nobility of character, and also with the means to back up his generous impulses. Lowell advanced the funds for the construction of the Westwood Astrophysical Observatory, and here for some years Professor Very conducted a series of notable investigations, rendering valuable assistance to Lowell and his work at Flagstaff Observatory. By the use of instruments which he devised himself, Professor Very established the presence of water vapor in the atmosphere of Mars, as well as other points having an important bearing on Professor Lowell's theory of the habitability of that planet."

In 1893 Very was married to Portia Mary Vickers of Glenshaw, Pa., and there survive five children, the pledges of a happy and congenial union which lasted until Mrs. Very's death in 1918. Mrs. Very was a woman of high education, and a fitting helpmeet to her distinguished husband by reason of her gracious tact and winning personality.

My acquaintance with Very began, not in a laboratory or college class room, but in the chorus of a May Festival. Very was gifted with a singularly pure tenor voice, and it was that which first attracted my attention to him. I sought his acquaintance, drawn not only by his voice, but also by the kindly gentleness of his face and his winsome manner. We became friends immediately and met almost daily thereafter until his removal from Pittsburgh to Providence in 1895.

Every Saturday afternoon, Very headed an expedition, composed of young men and women, that went forth seeking the hidden treasures of field and forest, mine and hill-side, railroad cuttings and ditches, and ancient river beds and terraces. With the skill born of scientific training, our leader followed the trail made by old Mother Nature in her wanderings down the ages. Very interpreted the hieroglyphics for us, and taught us how to read them for ourselves. Even the most arrant tyro among us was inspired by the keenness of our guide's perception and the brilliant deductions made by him in language we could readily understand.

We collected fossils, water-worn stones, bits of flint and chert as reminders of the glacial invasions from the far North, cocoons, flowers, mosses, lichens, ferns, snakes, frogs, insects,—in fact, everything of scientific interest that we happened to come across. And then, in the evening we assembled around his study table, either in the Allegheny Observatory or in his own home, and went over the finds and treasures of the day.

First of all, we were made to draw in our note books, with scrupulous care, the various objects. Very insisted upon every detail and slightest marking being faithfully copied. This procedure, naturally, sharpened our eyesight and made us see what otherwise we might have passed over carelessly. Then there was a great hunting through the excellent library at hand for articles and descriptions. Very superintended this element-

ary research and illumined what we found with the light of his almost omniscient knowledge. He never told us directly. He simply threw such a strong light upon the hidden truths, that we were able to see for ourselves, and to understand—a true Teacher!

One day in the early Fall of 1886, the writer having occasion to visit the Observatory, cut across fields, and came upon the rear of the building, where he beheld a most astonishing sight. Two men, Langley and Very, were standing, watching a strange contraption that looked like a giant pin-wheel whirling around with a great velocity. This was the celebrated whirling table invented by Langley, and used by him and Very in the classic research on aerodynamics—the first scientific attempt to make a heavier-than-air flying machine. This whirling table consisted of two thirty-foot arms that could be made to whirl at any desired speed. The arms were eight feet above the ground and were energized by a ten H.P. engine. On the end of each arm was a two pound brass plane, one foot square, hung vertically, and supported by a number of springs. These planes pushed against the air as the arms whirled, and the variations in pressure with the changing speeds were recorded automatically by a dynamometer chronograph in the Observatory. The soaring speeds and other data were thus determined.

These were the original air-plane experiments, and Very had quite as much to do with the development of the apparatus, and the interpretation of the results as had Langley, and should receive as much credit for the basal idea of a heavier-than-air flying machine.

Few realize the enormous amount of work that was preliminary to the mastery of flying dynamics. For example, practically every kind of bird that flies, from humming birds to condors, was subjected to a scientific study of wing structure in relation to weight and velocity of flight. Very was entrusted with the development of this phase of the research, and his facility in the matter of devising apparatus, as well as his keen perception of results, made it possible to draw conclusions vital to the success of the project. Incidentally, it is interesting to note that Very knew the genus and species of every bird used in the experiments, although there were fifty different species of humming birds alone that were studied.

Very was a many-sided man and wonderfully versatile. His knowledge of entomology, for example, was profound. This is indicated by an incident related to me by Edward A. Klages of Crafton, Pa. Klages is one of the foremost of the world's entomologists, and a high authority on Coleoptera. Klages in the year 1890 was associated with the late John A. Brashear. One day he was about to mail a package of beetles, and happened to show the box to Very. Picking up the beetles one by one, Very classified every one of the 150 beetles in the box, giving generic and specific names correctly. Although there were 91 families of beetles known in North America at that time, Very knew them all.

Klages also told me that Very's knowledge of the Lepidoptera was probably as extensive.

One family of beetles, the Elateridae, was the subject of careful study by Very. In conjunction with Langley, he made thorough research into the light-giving power of the genus Pyrophorus—commonly miscalled "fire-fly." Langley and Very were seeking the "heatless" light, and they accurately measured the intensity of the heat energy set free by these interesting and unusual beetles. The most useful of all the instruments used was the bolometer. The bolometer, as the reader will recall, was invented by Langley, and is simply a delicate thermal balance. These experiments, extending over a year, were productive of much curious information.

Very used the bolometer in a number of researches. One of the first uses to which he put this instrument was his determination of the distribution of the moon's heat. About the year 1889, a bulletin was sent out by the Utrecht (Holland) Association of Science and Art, offering a prize for the best essay on the distribution of the moon's heat with respect to the phase of the moon. Very was attracted by this opportunity for research. All the astronomical equipment of the Allegheny Observatory was at his disposal including an excellent bolometer. Very made careful determinations covering a period of three months, and sent the results of his research to the Society. The work was beautifully and accurately done, and the prize was awarded to him. He was also further honored by being elected to honorary membership in the Academy of Arts and Sciences of Utrecht.

As a matter of record, Very's mastery of bolometric methods gave him a great advantage in astronomical research. He will probably in after years be best remembered for his classic work on lunar temperatures, and his studies of the absorption and radiation of heat by our atmosphere. All of these important researches were bolometric. In the radiation study, published by the U. S. Weather Bureau in 1900, after a scholarly and scientific presentation of his data and his conclusions, he closes the monograph characteristically in these words:

> "We find the atmosphere playing the part of a conservator of thermal energy, and must gratefully admire the beneficent arrangement which permits the earth to be clothed with verdure and abundant life."

In 1910, Very published an article: "The Light of the Stars." In view of the recent development of theories as to the relation of matter and energy, this article was in the nature of a prophecy, and was fifteen years ahead of the world of science. He set forth, authoritatively, the theory that matter originates in the fixation of energy. To quote:

> "If we attribute the absorption of light in space to the ether itself, the radiant energy absorbed performs work upon the ether, presumably the generation of minute ethereal vortex-rings—the

elementary particles from which electrons are derived, or possibly the positive and negative electrons themselves, out of which the atoms are formed. From associations of electrons to atoms, from atoms to molecules, from molecules to the first tiny beginning of a cosmical crystalline sublimation, there is a continual progression and increase of size. Finally the widely dispersed material must be gathered from the immense voids of space into the germs of future worlds, and for this task the meteorites appear to be the appointed instruments."

Professor Very was philosophical in temperament and much given to speculation upon the problems of the universe. Sometimes controversies arose in the arena of science, and Very, being positive and outright in his opinions, made the sparks fly in the heat of argument. Yet he always preserved his even serenity of poise. No matter how bitter the argument, it was never a personal one with him. His delightful amiability, and above all, his sense of justice and fairness, made him an opponent that never stooped to personal revilement. He was an antagonist to be feared, yet ever lovable.

Professor Very was not of those who look into the abyss of space and see only gloom and nothingness. But rather he was one who looked upon the stars as the handiwork of the Creator, and rejoiced that "the heavens declare the glory of God." It is refreshing to review the work of a man so splendidly equipped in science, so closely in touch with the needs and problems of everyday life, who believed in the immanent love and fostering care of Almighty God. Throughout his writings is the spirit of reverence and adoration for the Power beyond. This is shown most beautifully in the closing paragraph of his "Light of the Stars":

> "Creation is not the bringing forth of an infinite number of dead structureless particles sent out as a set of miserable little waifs at some indefinitely remote epoch, and left to clash without guidance, without purpose. Creation is perpetual. The interiors of matter are seen to be more and more wonderful, more and more intensely active, as we approach the sacred portals where divine influx from the Soul of the Universe quickens into the energy which is matter."

* * * *

So passes, beyond the stars he loved so well, a man whose life was happily spent in the betterment of his fellow men.

The splendid offering of his high achievement, upon the altar of human welfare, cannot be measured in terms of time, or of fleeting adulation. The exquisite fragrance of such a life will ever abide.

Surely he has shown himself to be a workman that "needeth not to be ashamed."

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Professor Very was the author of many publications, beginning with "An Interesting Sun-spot," published in 1883, and ending with the "Epitome of Swedenborg's Science," now in press.

The following complete bibliography of his writings was made possible through the courtesy of my friend, Dr. Heber D. Curtis, who gave me the opportunity of using the excellent library of the Allegheny Observatory. A few of the articles were written in collaboration with Dr. Samuel P. Langley and others.

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REMARKS ON THE METEORIC PROCESSION OF 1913 FEBRUARY 9.

By WILLARD J. FISHER.

The "meteoric procession" of 1913 February 9 has been discussed by Chant,[1] Denning,[2] Davidson,[3] Monck,[4] and W. H. Pickering.[5] This was one of the most extraordinary meteoric phenomena ever observed, both in itself and for the extent of the region over which it was observed. It consisted of a succession of groups of large and small meteors which followed apparently the same track and were several minutes in passing. Observations, agreeing in time pretty well, and fairly well with a great circle path, were reported from Saskatchewan to the equatorial Atlantic, a distance of over 5200 miles.

The accompanying figure, reduced from a plot on a great circle chart of the North Atlantic, shows the more important of the stations, except that in Saskatchewan, which is not in the range of the chart.

The collection of the data was mostly carried out by Prof. C. A. Chant, without whose initiative and energy this remarkable event would have been immediately forgotten. All of the reports from North America and Bermuda were collated by him, and he expressed the hope that ships at sea might be heard from. By an appeal in the *Nautical Magazine* Mr. W. F. Denning secured reports from the steamships *Bellusia* and *Newlands,* in the tropical Atlantic. Prof. W. H. Pickering got a statement from the United States Weather Bureau about conditions of cloudiness in the northeastern United States, and procured from the files of the U. S. Hydrographic Office reports from the steamships *Tennyson, Manuel Calvo,* and *Custodian,* nearer the American coast. All of these vessels except the *Calvo* were probably British tramps.

The total number of reports thus secured was 144; of these, 5 came from ships at sea, 2 from Bermuda, 135 from Canada, (2 from Saskatchewan, the rest from Ontario, mostly lower Ontario), and 2 from the United States. One of the last came from Marshall, Mich., in the lower peninsula, and was a local newspaper item, from which it could be deduced only that fireballs had been seen; the other came from Watchung, New Jersey, and was definite.

As the path of the meteors certainly lay over northern Minnesota, the

1a. C. A. Chant, *Jour. R. Astr. Soc. Can.*, **7**, p. 145-215, 1913.
1b. Same, **7**, p. 412-413, 1913. 1c. Same, **7**, p. 438-441, 443-447, 1913.
2a. W. F. Denning, *Jour. R. Astr. Soc. Can.*, **7**, p. 404-412, 1913.
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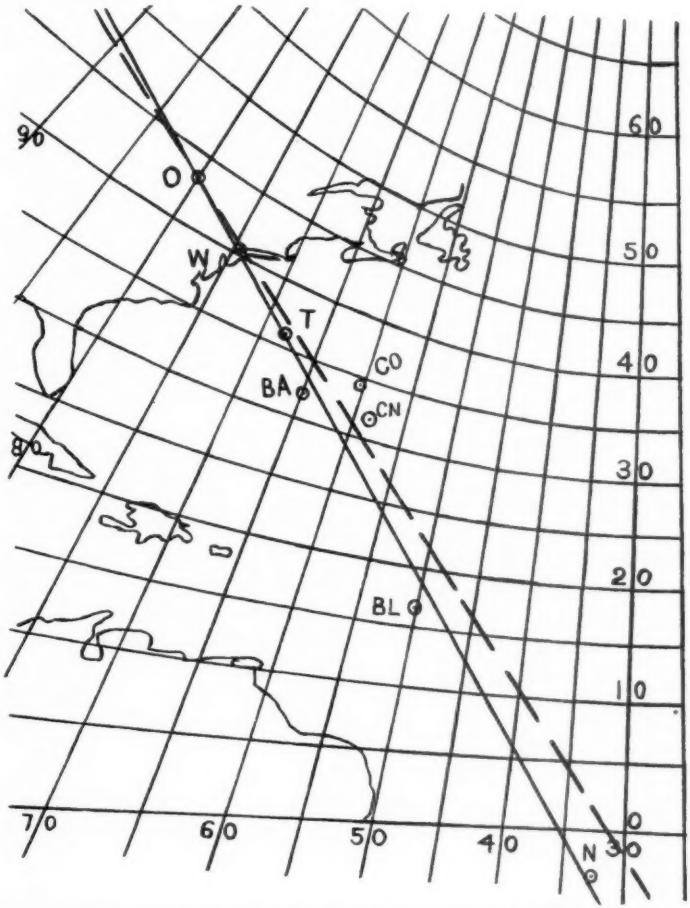
3a. M. Davidson, *Jour. R. Astr. Soc. Can.*, **7**, p. 441-443, 1913.
3b. Same, *Jour. B. A. A.*, **24**, p. 101-108, 1913.
4. W. H. S. Monck, *Jour. R. Astr. Soc. Can.*, **8**, p. 112-116, 1914.
5a. W. H. Pickering, *Pop. Astr.*, **30**, p. 632-637, 1922.
5b. Same, **31**, p. 96-104, 443-449, 501-505. 1923.

two peninsulas of Michigan, southwestern New York, northeastern Pennsylvania, northern New Jersey, and western Long Island, it seems most remarkable that only two reports of this spectacular event should have come from these states. Prof. Pickering learned from the Weather Bureau that at 8:00 P.M., E.S.T., it was partially cloudy in western New York, Pennsylvania, and Maryland, but practically clear in all other regions where the meteors should have been visible. The present writer has learned from the "pole star recorder" plates at the Harvard and



GREAT CIRCLE CHART OF OBSERVERS' STATIONS, 1913 FEBRUARY 9.
O, Ontario station; W, Watchung, N. J.; T, *S.S. Tennyson;* BA, Bermuda; CO, *S.S. Calvo;* CN, *S.S. Custodian;* BL, *S.S. Bellusia;* N, *S.S. Newlands;* solid line, Pickering's great circle; dotted line, Chant's great circle.

Blue Hill Observatories that after 9:00 P.M. the pole was entirely free from clouds for the rest of the night. Previous to that there was partial cloudiness. So the meteors, which passed some minutes after 9:00, were quite possibly visible at both these stations, in the southwest at an angular altitude of not over 11°. A renewed inquiry of the Weather Bureau, asking for details of cloudiness at 8:00 P.M., E.S.T., at all the Weather Map stations in the region concerned, shows that reports on the meteors were to be expected from Minnesota, upper and central lower Michigan, and especially from eastern New York and Pennsylvania, northern New Jersey and southern New England, on account of generally favorable conditions and great density of population.

Two suppositions may be made: that the apparitions were local—which is hard to believe,—and that the call for reports was not sufficiently widespread to attract attention in the northeastern United States. Chant does not mention appealing directly to the press outside of Toronto. Even so, it remains curious that the news collecting agencies of the United States should have ignored the matter, and that it should not have excited the interest of any scientific men in the United States.

With this example before us, it is plain that a paucity of reports about any fireball does not constitute an argument against its reality.

After studying the reports from Ontario, Chant decided that the path of the meteors passed through the zenith of the point W 80° N 43° 24′. Denning and the other computers are inclined to put this point farther south by 3′. As the width of the procession could hardly have been less than some miles, the choice is immaterial, for this fundamental "Ontario station."

Chant then assumed that the meteors seen in Saskatchewan, Ontario, New Jersey, and Bermuda formed part of the same narrow procession, being in some cases the same objects, and that the projected path was a great circle, passing through Pense, Sask., and the Ontario Station, with an interval of 1206 miles between. This great circle passes 5.3 mi. on the north from Watchung, and 131 mi. northeast of the Bermuda station; thence over the South Atlantic Ocean, 600 mi. away from the Cape of Good Hope.

With information in hand about meteors seen passing to N.E. of *S.S. Bellusia* and to W. of *S.S. Newlands,* both in the tropical Atlantic, Pickering made the same assumptions as to the identity of the meteors and their great circle path, but adopted as fundamental his Ontario Station and a position between the *Bellusia* and the *Newlands.* His great circle then passed through W 80° N 43° 21′, and cut the meridian there with a true bearing S 55° E, differing 3°.8 from Chant's great circle bearing. He computed the distance of the Pense station from this great circle, and found that Pense lay 108 mi. to S of his great circle, so that the meteors should have been seen passing at an altitude of 26° instead of directly overhead, as reported. While Pickering does not mention the Watchung observation, of meteors passing directly overhead, so

that "We all had to hold our heads away back to see them," nevertheless Watchung lies 20 mi. away from his great circle, and the meteors would hardly have required any noticeable exertion to see them pass along his path.

The height of the meteors at the Ontario Station was computed by Chant from Ontario reports. Three of these give remarkably concordant results, 26.2, 26.7, 26.3, mean 26.4 mi.* based on two sketches of the path across Orion, and on one instrumental determination of the angular altitude of a telephone pole past whose top the meteors were observed to go. Other computations were based on estimates solely, which required diminution of reported altitudes by one-half or one-third. Unfortunately, instead of resting on the three best observations, Chant used a mean of 26, 31.1, and 43.6, or 34 mi., which gave a considerable overweight to the poor observations. There seems to be no reason to abandon the height 26.4 miles at the Ontario Station.

The earth-shaking detonations which accompanied the passage of the meteors in Ontario (but were not reported elsewhere) argue for the lower height. According to Denning,† in 90 good instances of detonating fireballs, the average height at ending was 20.3 mi. About half ranged from 20 to 28 mi. Only 4 were above 34 mi. The sound limit or level for audible detonations seems to lie about 34 mi.; the few above that are uncertain . . . It is not the swift meteors that are detonating, for they rarely fall below 45 mi. . . . The slow, long-pathed fireballs from low radiants are generally responsible, for they traverse lower regions of the air.

But all the computers except Chant, including Denning, insist on a height of 34 mi. or more at the Ontario Station, for dynamical reasons, combined with the tacit assumption of identical meteors and great circle paths. If the meteors were identical from Saskatchewan to the equator, then they must have travelled as satellites of the earth through the upper atmosphere, with velocity not less than 4.9 mi/sec, the velocity in a circular orbit. But the resistance of the air at 25 mi. height, it was computed, would have slowed down the meteors and brought them into the Atlantic long before reaching the equator, unless the height at the Ontario Station was considerably more than 26 mi.; hence 26 mi. was rejected.

To the writer it seems that all the facts of *observation* can be reconciled qualitatively after abandoning the hypothesis of simplicity of the phenomena (implied in identity of the meteors and in great circle paths), and by considering the spheroidal form of the earth and its diurnal rotation. The former has been considered in this connection by no one, the latter only by Pickering, but only in computing the deviation producible by the eastward "wind" of the rotating atmosphere; this he

*Computed by the writer, taking account of the curvature of the earth, which was omitted by Chant.

†*Observatory*, **49**, p. 314-315, 1926.

finds to amount to only a mile or so during the passage from Ontario to the equator.

A chasing meteor captured by the earth's attraction and turned into a satellite would revolve in a nearly plane orbit about the earth's center. The trace of such a plane on the spheroidal earth would pass through points whose astronomical latitudes would differ from their geocentric latitudes determined by the trace of the plane on the celestial sphere. Computation of Chant's great circle points, starting from the geocentric positions of Pense and the Ontario Station, and reducing back from geocentric to astronomical latitudes, gave the writer such small differences that they could be ignored.

But a satellite-meteor starting from latitude 50° or 43° and traversing a nearly circular orbit toward the equator would find rising before it the equatorial bulge of the spheroidal earth, and above this an atmosphere in which it would continually become more deeply entangled. The difference from Pense to the equator, for a circular orbit would amount to about 7 mi. So that the escape of such a satellite would be generally impossible for this reason alone, unless the height at 50° were more than 26 mi. Even a definitely elliptic velocity would not suffice, below a limit which it is not easy to compute.

The attraction of the equatorial bulge would produce a small southerly drift.

Ignoring the spheroidal form, the projection on the earth's surface of the path of a satellite moving from higher to lower latitudes cannot be a great circle. Suppose one going from the Ontario Station southeastward to the equator in 15 min. Imagine a point in the satellite's orbital plane, exactly over a certain point on the equator when the satellite is over the Ontario Station. But when the satellite arrives 15 min. later at this orbital point it is then above quite a different point of the equator, 520 mi. to westward of the original equatorial point. In fact, the trace of such a satellite on the spherical or spheroidal earth must be a curve concave westward and with a point of inflection on the equator.

Imagine satellite-meteors passing through the zeniths of Pense and the Ontario Station on their way to the equator. Their true trace then cuts Chant's great circle at these two points, lies to NE of it between them, and to SW of it the rest of the way. Again imagine them passing through the zenith of the Ontario Station and between the *Bellusia* and the *Newlands*. Their true path would lie to NE of Pickering's great circle all the way, but backward from the Ontario Station it would lie to SW. In other words, such meteors could pass through the zeniths of Pense, the Ontario Station, and Watchung, as observed, on the proper side of the Bermudas and of each ship clear past the equator to the *Newlands*.

A tangent to the true path at the Ontario Station would lie between the Chant and Pickering great circles, and prolonged as a great circle to the equator it would intersect the equator between them, probably

nearer to Chant's great circle. The great circle chart plot of Chant's and Pickering's great circles, giving a difference of longitude on the equator of 3°, supposes the true difference of this tangent and the trace of the meteors to be 2° or 8 min.,—which the writer supposes to be not unlikely. The distance Ontario Station to *Newlands* was computed as 4353 mi.; then the velocity would be about 9 mi/sec, which lies between the limits, 5 to 10 mi/sec, originally computed by Chant from duration estimates in Ontario.

The heights at points beyond the Ontario Station depend on the observed angular altitudes combined with the projected path in the neighborhood of the observer. The position of this projected path depends on the computer's theory as to its nature, which consequently affects the heights derived. The heights over the Atlantic would be:

Bermuda (Chant's circle) 79.6 mi., (Pickering's circle) 36 mi.

Bellusia and *Newlands,* Chant's circle does not fit the observed bearings of the meteors; using Pickering's circle, *Bellusia,* 45, *Newlands,* 14.

There seem to enter in too many uncertain or unknown factors to lead to a decision as to whether the bodies seen in Saskatchewan actually passed the other North American observers, Bermuda, and the ships. The time at Bermuda seems to be uncertain. The ships all give moments of apparition, but in "ship's time," with no specification of the noon meridian for ship's time. Consequently the time of passage cannot be got that way. It is not all impossible, and the writer is inclined to believe, with Davidson, that the objects seen in Saskatchewan were partly destroyed by atmospheric ablation, partly entangled in the deeper atmosphere over the equatorial bulge and sunk in the Atlantic; and that the objects which passed the equator were originally higher members of the stream or swarm of meteors, some of which may even have escaped from the equatorial bulge and got away again. Once away, perturbations due to the equatorial bulge and the moon would divert them so that they would never reappear.

SECOND NOTE ON PERSONAL EQUATION IN OBSERVING OCCULTATIONS.*

By EDWARD C. PHILLIPS, S. J.

The first Note on this subject was presented by the author at the Madison Meeting of the American Astronomical Society and an Abstract of it appeared in POPULAR ASTRONOMY, Vol. XXXV, page 491. That Note dealt with an experimental determination of the personal equation of two observers carried on at Georgetown College Observatory. The object of this present Note is to tabulate the results of

*Presented at the New Haven Meeting of the American Astronomical Society, December 29, 1927.

previous investigations and from an examination of these data to indicate:

1) The range of magnitude of the personal equation for different observers,
2) The steadiness or variation of the personal equation for a single observer during a long period of time,
3) The dependence of the personal equation on the method and conditions of observation.

Our consideration is restricted, except in the few instances noted below, to *immersions or disappearances at the dark limb of the Moon.*

Part I. Range of Personal Equation.

The following Table gives the personal equation of various observers as experimentally determined by some form of "personal equation machine" involving the mechanical occultation of artificial stars. The first column gives a reference number to the source from which the information has been taken: the third column indicates the means used for recording or estimating the time of disappearance, "Chr." meaning that the moment of disappearance was recorded by the observer with the electric chronograph; "E.&E." meaning that the usual eye and ear method was followed, and "Stw." meaning that the disappearance was recorded with a stopwatch which was compared, within a few minutes after the observation, with the standard clock of the Observatory.

TABLE I.

Ref.	Observer	Method	Per. Eq.	Ref.	Observer	Method	Per. Eq.
1	Young	Chr.	—0^s.25	4	Przybyllok I	Chr.	—0^s.32
1	McNeil	Chr.	—0.10	4	Przybyllok II	Chr.	—0.46
2	Renz	Chr.	—0.40	4	Przybyllok	E.&E.	—0.03
2	Renz	E.&E.	—0.03	4	Voelkel	Chr.	—0.31
3	Jost	Chr.	—0.33	5	Barry	Chr.	—0.29
4	Nobile	Chr.	—0.26	5	Phillips	Chr.	—0.32
4	Nobile	E.&E.	—0.16	6	Barry	Stw.	—0.04
4	Benes	Chr.	—0.32	6	Phillips	Stw.	—0.07
4	Benes	E.&E.	+0.09				

References.

1. *Sammlung der Beobachtungen von Sternbedeckungen während der totalen Mondfinsterniss,* 1888 Januar 28: herausgegeben von Otto Struve, page 56 (St. Petersburg, 1889). Cf. also *Astronomical Journal,* Vol. XIX, page 168 (1899).

2. *Astronomische Nachrichten,* Vol. 119, pages 145 ff. (1888).

3. *Astronomische Nachrichten,* Vol. 181, pages 203 ff. (1909).

4. *Der persönliche Fehler bei der Beobachtung von Sternbedeckungen,* von E. Przybyllok; in the *Mitteilungen der Grossh. Sternwarte zu Heidelberg,* No. XIV (1909). This seems to be the most comprehensive article on the subject so far published.

5. *Popular Astronomy,* Vol. XXXV, page 491 (1927).

6. Not hitherto published.

The above Table gives the *absolute personal* equation as determined by direct measurements. Another way of estimating the range of personal equation is to examine the *relative equation* of two observers by noting the difference in the recorded time of a single occultation as

given by the two observers observing at the same observatory. This will not give us directly the magnitude of the personal equation of either observer but will directly show how great a difference may be expected between several records of identically the same occurrence, and will indirectly show in a general way the magnitude of the absolute personal equation which will be at least one half of the relative equation and probably much more than one half. The following Table gives us this information.

TABLE II.

Ref.	Observers	Rel. Per. Eq.
7	Petersen-Juergensen	—0^{s}59
8	Bessel-Argelander	—0.28
9	Cape Observers, 1896-1906	±0.40
10	Cape Observers, 1907-1922	±0.36
9	Finlay-Innes	+0.3
9	Lowinger-Innes	—0.2
11	Hall-Burton	+0.03
12	Hall-Bower	—0.09

REFERENCES.

7. *Astronomische Nachrichten,* Vol. 18, page 391, (as quoted by Przybyllok).
8. *Astronomische Beobachtungen auf der Kgl. Universitäts-Sternwarte in Königsberg,* Abt. 8, page VI (1823). These observations included reappearances of fairly bright stars at the dark limb of the Moon.
9. *Union Observatory Circular* No. 55 (1922). The relative personal equation was derived for the period 1896-1906 by Innes from 225 duplicate observations of disappearances published in the earlier *Cape Annals.* These included a few disappearances of very bright stars at the bright limb.
10. *Cape Annals,* Vol. VIII, part VII. This value rests on only nine duplicate observations.
11. *Astronomical Journal,* Vols. XXVI to XXXVII (1912-1927).
12. *Astronomical Journal,* Vols. XXXI to XXXVI (1918-1925).

PART II. VARIATION OF AN OBSERVER'S PERSONAL EQUATION IN COURSE OF TIME.

Unfortunately there are no records of repeated determinations of a single observer's absolute personal equation for any very long period of time. There are a few records of determinations made by the same observers at intervals of a few months, and these are given in the next table.

TABLE III.

Ref.	Observer	Interval	Per. Eq.	Change
13	Przybyllok	2 months	—0^{s}32 and —0^{s}46	—0^{s}14
14	Barry	3 months	—0.29 and —0.30	—0.01
14	Phillips	3 months	—0.32 and —0.33	—0.01

REFERENCES.

13. Same as Ref. 4 given above.
14. Hitherto unpublished.

The change or steadiness of personal equation can also be judged, though with less definiteness, from comparisons of the relative personal equation of two or more observers who have made duplicate observations at the same place for a series of years. The long list of observations made at the U. S. Naval Observatory and published in successive

volumes of the *Astronomical Journal*, quoted above under Ref. No. 11, offers an excellent series of this kind covering a period of some fifteen years, and the results of an examination of this material is indicated in Table IV. The first column indicates the periods of observation; the second column shows the number of duplicate observations on which the quantities in column three are based; this third column gives the relative personal equation of Professor Hall and Mr. Burton for each of the indicated periods of time, and these quantities are obtained by subtracting the time as recorded by Mr. Burton from that recorded by Professor Hall for the same disappearance; the recorded times are given in the *Journal* only to tenths of a second and the hundredths indicated below are the results of taking the average of all the observations falling in each period. The last two columns give the corresponding quantities for Professor Hall and Mr. Bower.

TABLE IV.

Years	No.	H.-Bn.	No.	H.-B.
1912-16	15	+0^{s}03	..	.....
1916-17	6	+0.03	7	—0^{s}16
1917-18	14	+0.02	9	—0.07
1920	..	.....	3	—0.03
1922	..	.....	8	—0.03
1923	..	.....	11	—0.10
1924-25	6	—0.09	18	—0.09
1926	3	—0.07	..	.....
Mean values for two major periods				
1912-18	35	+0.03	16	—0.11
1920-26	9	—0.08	40	—0.08

The figures in column three show a definite but small change of relative personal equation amounting to —0^s.11 in the entire interval of fifteen years: the values in the last column differ so little for the extreme periods that they offer no conclusive evidence of any change. It seems reasonable to conclude that the absolute personal equation of all three observers has remained very steady, probably not changing by more than one tenth of a second in about ten years or more.

With regard to the change of —0^s.14 within a period of two months indicated above in Table III, Przybyllok states that while the fact is certain he can offer no plausible explanation of it.

Part III. Dependence on Methods and Conditions of Observation.

Table I gives us sufficient material for estimating the effect on the personal equation resulting from the use of different methods of recording the moment of disappearance. This effect is summarized in the following Table in which the first column indicates the method used; the second column shows the number of *observers* involved; the third gives the average of the personal equations of these observers; the fourth indicates the variability of the personal equation of a single observer and represents the average deviation of the individual ob-

servations of that observer from the mean of all of his observations; the last column gives the values of the personal equation of the observer having the smallest and of the observer having the largest equation respectively.

TABLE V.

Method	No.	Av. Per. Eq.	Variation	Range
Chronograph	13	—0^{s}31	about ±0^{s}03	—0^{s}10 to —0^{s}46
Eye and ear	4	—0.03	about ±0.20	+0.09 to —0.16
Stopwatch	2	—0.06	about ±0.10	—0.04 to —0.07

It will be noticed that whilst the chronograph gives the largest personal equation or "lag," it also gives the steadiest lag, whilst the eye and ear method gives the smallest lag but the greatest variability from the average in the individual observations. The stopwatch observations hold a middle position in both respects. In other words the chronograph method of recording occultations is subject to the largest systematic error but involves the smallest accidental error, whilst the eye and ear method gives the smallest systematic error but the largest accidental error (about 7 times as large as the systematic error). Hence if one has the necessary means of determining his systematic error with the chronograph, this method of recording will give the best results.

Our last Table shows the dependence of the personal equation on the magnitude of the stars observed. This dependence has not been studied very extensively, except in two cases the details of which may be found in the original papers of Renz and Przybyllok referred to above under Ref. Nos. 2 and 4. It should be noted that the aperture of the telescope used must have an appreciable effect on the magnitude equation: the material cited from Przybyllok was secured with a small telescope of only 32 millimeters aperture.

TABLE VI.

a) Eye and ear method: Observer Przybyllok

Star Mag.	Mean Eq.	Mean Error
2.0 to 5.4	+0^{s}003	±0^{s}18
5.9 to 7.0	+0.035	±0.17
7.5 to 8.5	+0.085	±0.19

b) Chronograph method.

Star Mag.	Mean Eq.	Mean Error	Observer
4 to 5	—0^{s}40		
6	—0.47	±0^{s}045	Renz
7	—0.49		
8 to 9	—0.59		
0 to 5	—0.35	±0.063	
5 to 7	—0.47	±0.074	Przybyllok
7 to 10	—0.65	±0.117	

The third column gives the mean error *of one observation;* the values given in column two depend on a large number of individual observations, generally twenty or more, and hence the mean error of these values will be much smaller than that indicated in column three.

One final remark should be added: the investigators in most cases state that they consider the values obtained from artificial occultations as representing their *minimum personal equation* since the laboratory conditions under which they were obtained were more favorable than the conditions under which observations of actual occultations are usually made.

GEORGETOWN COLLEGE OBSERVATORY, WASHINGTON, D. C.

A SERVICEABLE COUNTRY OBSERVATORY.

By CHARLES D. HIGGS.

After unsuccessfully combatting for some time with makeshift coverings for my 5-inch Clark equatorial, the rigors of our Wisconsin climate finally drove me to the consideration of some form of permanent housing. Obviously the revolving dome was the desired type, but the constructional difficulties involved seemed to make it hopelessly unfeasible, where one's only resources are the small town lumber yard, the local

FIGURE 1.

hardware store and the assistance of the village carpenter. The helpful literature on such types of construction is very meagre, and for the most part unavailable to the American amateur. One finds details of several forms of housings in Mr. Bell's invaluable handbook, "The Telescope," especially regarding the Romsey type observatory. This latter, however, is crude and unsightly, and very unprofessional, not

only as regards operation, but also in looks. The amateur is very covetous of that professional atmosphere which is conveyed by the very appearance of the hemispheric dome.

I had about given up hope for anything in the dome line when Mr. Wm. Braid White's article in POPULAR ASTRONOMY (Oct., 1926) heartened me to attempt something similar. But even here there were features which approached the impossible for a rustic to materialize. Mr. White, in this article, acknowledges his indebtedness to the late Mr. Parkhurst for the track and rollers, and it was in the construction of these features that I anticipated my greatest trouble, with the materials at our command. The simple manner in which we worked it out has been so satisfactory that I am passing it along, in hopes that our experience may at least suggest something of assistance to other amateurs.

The little building, completed, as shown in Figure 1, represents an outlay of $60.00 for material, and six days labor for a carpenter, with my puttering assistance.

I found that the smallest space in which I could comfortably work with my 5-inch telescope comprised a diameter of ten feet, so we accordingly laid everything out in that proportion. The building proper is of the simple cheese-box type, consisting of sill and plate, joined together by studding spaced one foot apart to give a rigid bearing for the revolving dome. Celotex is laid over this frame for sheeting. This is bent around the circular walls very easily, and when painted weathers well and gives a smooth finish. Obviously the height of the building will be governed by the height of the individual mounting, which in my case is such that the building walls are six feet high.

As the whole structure is quite light we used cedar posts, driven into the ground, for a bearing. For greater facility in sawing, the plate and sill, as well as the sill and rafters of the dome, were all cut from 1-inch No. 2 pine (12-in. wide). As long an arc as possible of the ten-foot circle was cut out each time, and from these sectional arcs the whole plate and sills were built up in two-ply lamination. These circles were sawn of the thickness which made them flush with the 2x4 studding, both inside and out.

The sill for the dome was cut about an inch larger in inside diameter, in order that this would fit around and over the plate of the building, and revolve freely. The rafters were likewise cut to this latter circle and spliced together in the same manner. As the slit must be carried beyond the zenith, this section of the dome must be erected first, and the rafters cut to their varying lengths as they meet the sides of the slit (See Figure 2). In our case we made the slit only eighteen inches wide, which was a mistake as I find that the field is so narrowed that frequent turning of the dome is necessitated.

For sheathing the dome we used a good heavy grade of duck, tacked on. This is much cheaper than tinning, and, if shrunk, sized and painted, will even outwear the latter. As the whole dome is so light this all

can be done on the ground and lifted into place when completed. This lightness is one great advantage of the duck roof. Most of the tinned domes with which I have had any experience have been such ponderable

FIGURE 2.

affairs that they were moved with great difficulty, and unless fitted very accurately and mounted on very perfect bearings could not be revolved by one man.

Thus far we had got and then we were stumped. How to revolve the dome! I went to the hardware store in quest of suggestions—castors, pulleys, garage-door tracks, etc. I was on the point of ordering something especial made up when a boy came in to buy wheels for his roller-skates. That was it! I bought sixteen roller-skate wheels and the same number of ¼-inch carriage bolts and hurried home. Eight of these wheels I bolted directly through the plate of the building as bearing rollers for the sill of the dome, and eight on top of the plate as thrust bearings against the side of the dome sill, to hold the latter in circular alignment.

It worked! With a little extra push it actually spun.

Now there was the shutter to be worked out, and I had always heard that this was the amateur's worst stickler. To build it of wood would call for rafters of such thickness as to be out of proportion with our small structure, so here we were forced to call in the services of another than the carpenter—the blacksmith. It was an easy matter for the smith to roll out from light angle-iron two arcs of a slightly larger circle than that of the dome, (so that the shutter will slide over the latter). These, bolted together by end cross-members, made the frame, and some

thin lattice bolted to the angle-iron gave us something to which to tack the duck covering. Two roller-skate wheels, top and bottom, running in angle-iron tracks which are bolted to the dome, and operated by ropes and pulleys from the inside, completed a shutter which works as freely as the most fastidious professional could desire.

In order to secure additional protection against the weather a small apron was bent around the bottom of the dome, projecting a few inches below the sill, and aprons were also laid along the sides and top of the shutter, securing a weather-tight joint against the combing of the slit, when closed. As originally built we laid no floor in the building, merely filling in flush with sifted cinders. This was entirely satisfactory, but the chipmunks would not leave it so. As I was continually stumbling into fresh burrows in the dark I was compelled to lay a light flooring to keep the saucy little rodents in their proper haunts.

FONTANA, WISCONSIN.

ERRONEOUS PERIODS OF SPECTROSCOPIC BINARIES.

By OTTO STRUVE.

Our methods for finding the period of a spectroscopic binary are essentially empirical. The observer has, let us suppose, a fair number of spectrograms at his disposal. He notices that some of them give very large velocities, while on others the measured values are intermediate or negative. By trial he finds that a number of observed maxima can be satisfied with a period of X days. He then applies this value to the observed minima and again he finds a satisfactory fit. By means of distant maxima and minima he adjusts the period and makes it represent the whole range of observations. If he is careful he looks into the possibility of submultiple values of X. Dates for which there are no observations may by chance have happened to arrange themselves in such a way that the true period is not X, but X/2 or X/3 or X/n. If all submultiples are eliminated he computes the phases of his observations and draws a velocity curve. The observed velocities will in most cases represent more or less closely a certain curve that can be interpreted as being due to orbital motion in a binary system. To check the period still further the observer will use any other published observations that are available. He may also compute an ephemeris for some time ahead and get additional observations to compare with his predictions.

If all such tests give satisfactory agreement, the observer assumes that his period is correct and that the velocity-curve will give the true orbital elements of the binary.

But the fact is that there are many stars in which the chances are 2 to 1 that his period is wrong. In a still greater number of stars the chances

may be 1 to 1, or 2 to 1 in favor of his period. But there are few stars, indeed, where the observer can be quite certain of his deductions without further investigation.

The trouble arises from the lack of observations during the daytime hours. No star can be followed at any one observatory continuously; if its true period of revolution is more than half a day, daylight will cut out certain portions of the velocity curve, and a number of successive revolutions must be used to reconstruct the whole curve. Matters become still more serious if the star is far to the south and can be observed only when close to the meridian. In that case the observations follow one another at regular intervals of about 24 hours, or multiples thereof, and the shape of the curve between observations must be reconstructed artificially.

It has been known for a long time that a period cannot be ascertained without ambiguity when observations are made at regular intervals. Barring all values shorter than 0.5 day, there will in general be three distinct periods that satisfy the observations.[1] Suppose we consider two observations made on successive nights: $V_1 > V_2$. It is obvious that both points may lie on the same descending branch of the velocity-curve, in which case the period will be longer than two days. But it is also possible that a minimum of the curve has occurred between V_1 and V_2, which would yield a period of more than one and less than two days. Finally, it is conceivable that between V_1 and V_2 the curve passed through a maximum. This would give a third alternative of less than one day. Assuming that $p_1 > p_2 > 1^d > p_3$ the different values are related among one another in the following way:

$$p_2 = p_1/(p_1 - 1) \qquad p_1 = p_2/(p_2 - 1)$$
$$p_3 = p_1/(p_1 + 1) \qquad p_1 = p_3/(1 - p_3)$$
$$p_2 = p_3/(2p_3 - 1) \qquad p_3 = p_2/(2p_2 - 1)$$

All of these must be expressed in units of the interval between successive observations. Spectrographic work is frequently limited to small hour-angles, in which case the interval is one sidereal day.

Old as this information may be, it has been frequently overlooked. I for one have been guilty of this neglect, and have in the past usually considered my task finished after a satisfactory velocity-curve had been derived. This is quite insufficient; all three periods must be investigated independently. For almost any star each of the three periods gives a plausible curve. If all observations fall close to the meridian, the scattering will be the same in all three cases. If observations have been made in different hour-angles, the scattering will be no longer identical, and we shall be fairly safe in assuming that the curve giving the least amount of scattering corresponds to the true period.

I have recently found a very striking example of a star in which all three periods give plausible curves. Intercomparison, however, shows that the published value gives the largest amount of scattering and there

[1] Hagen. *Die Veränderlichen Sterne*, **1**, 622, 1920.

can be no doubt that it is not the period of revolution of the binary.

The name of this star is 31 Crateris (also called 31 Corvi) or Boss No. 3138. J. B. Cannon determined its orbit[2] at Ottawa and found $p = 1.50307$ days. The residuals were large, but not more so than could reasonably be attributed to the poor quality of the stellar lines, in this B3 spectrum. Observations were made during two years, and all of them fit the published curve with a probable error of ± 13 km/sec. This is large, but since $K = 119$ km/sec, the fit may be regarded as satisfactory. There were four early observations from Mount Wilson and all of them agreed with the curve. When I came to measure the Yerkes spectrograms[3] of this star I found that "Cannon's orbit satisfies our observations in general, although the residuals are large . . . This is not surprising since the lines are poor." All appearances seemed to be in favor of the published orbit.

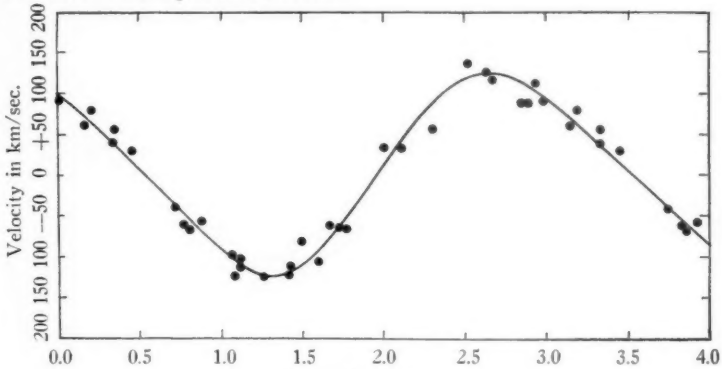


FIGURE 1.

VELOCITY CURVE OF THE SPECTROSCOPIC BINARY 31 CRATERIS

Computed with $p_1 = 2^d.96311$.

My suspicion was aroused by one very large residual of —74 km/sec. The detailed measures of the corresponding plate are given in J. B. Cannon's paper, and the results from three lines agree rather well, so that an actual error of 74 km/sec, or something like 0.05 mm, in the measurement seems quite unlikely.

Assuming then that $p_2 = 1.5031$ mean solar days $= 1.5072$ sidereal days, we find: $p_1 = 2.9715$ sidereal days $= 2.9631$ mean solar days; and $p_3 = 0.7482$ sidereal days $= 0.7461$ mean solar days. The corresponding velocity curves for all three periods are shown in Figures 1, 2, and 3. The best representation is obtained with $p_1 = 2.9631$ days, and it is quite probable that this is the true value. I have made no attempt to represent the few Mount Wilson and Yerkes plates, but it is clear

[2] *Publications of the Dominion Observatory, Ottawa,* **4**, 125, 1917.

[3] *Astrophysical Journal,* **64**, 25, 1926, Star No. 222.

that by slightly modifying p_1 and p_3 this can be done just as well as with p_2; the difference in longitude is, of course, insufficient to give a

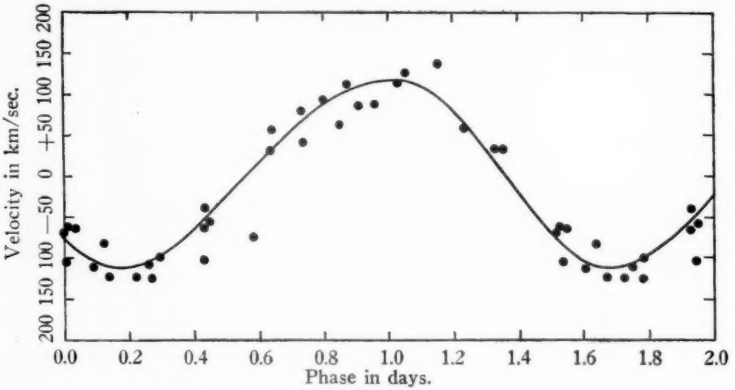


FIGURE 2.

VELOCITY CURVE OF THE SPECTROSCOPIC BINARY 31 CRATERIS
Computed with published period $p_2 = 1^d.50307$.

materially different velocity at Mount Wilson. The orbital elements are obviously also changed and, in Table I, I give all three sets as derived by means of Pogo's modification[4] of the hodographic method of Laves. The first set is probably the true one, the second is almost identical with that of Cannon, and the last one corresponds to $p_3 = 0.74612$ day, which is not probable because the scattering is appreciably larger than that corresponding to p_1.

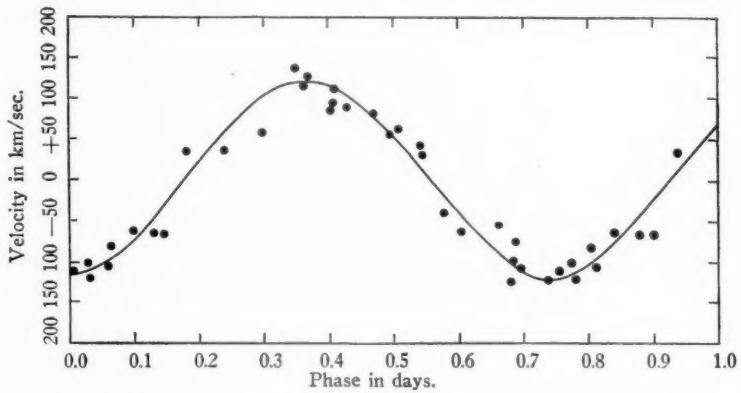


FIGURE 3.

VELOCITY CURVE OF THE SPECTROSCOPIC BINARY 31 CRATERIS
Computed with $p_3 = 0^d.74612$.

[4] *Astrophysical Journal*, **67**, 1928.

TABLE I. ORBITAL ELEMENTS OF THE SPECTROSCOPIC BINARY 31 CRATERIS.

Period	$2^d.9631$	$1^d.5031$	$0^d.7461$
Semiamplitude	120 km/sec.	112.5 km/sec.	118 km/sec.
Eccentricity	0.10	0.07	0.00
Long. of Periastron	259°	106°	0°
Time of Periastron	$1^d.88$	$1^d.46$	$0^d.37$
Velocity of System	+5 km/sec.	+7 km/sec.	+4 km/sec.
$a \sin i$	4,700,000 km.	2,200,000 km.	1,200,000 km.
Mass-Function	0.45	0.21	0.13

The phases are counted from J. D. 2,421,000.000.

Similar errors have doubtless occurred often. From this point of view I have investigated four stars and in two of them the published period is probably incorrect, in spite of the plausible character of the velocity curve. C. Hujer[5] has recently shown that a similar case is represented by 36 τ^9 Eridani. Our former period[6] $p_3 = 0.8544$ day is not the only one possible, and $p_1 = 5.9542$ days gives a very satisfactory representation. It is not possible, however, from observations made at the Yerkes Observatory to decide definitely which value is the correct one. Finally, A. Pogo[7] has computed alternative periods for η Orionis, but in this case the assumed value of 7.98922 days is doubtless correct. A few other cases, such as VV Orionis[8] and Y Cygni[9] have been known previously. A summary may be found in the following table.

TABLE II. ALTERNATIVE PERIODS FOR CERTAIN SPECTROSCOPIC BINARIES.

Star	Published Period	True Period	Alternative Periods
31 Crateris	$p_3 = 1^d.50307$	$p_1 = 2.9631$	$p_3 = 0.7461$
τ^9 Eridani	$p_3 = 0.8544$	$p_1 = 5.9542(?)$	$p_2 = 1.1979$
+56°2617	$p_3 = 1.3605$	$p_1 = 3.7105$	.....
b Persei	$p_2 = 1.5273$	$p_2 = 1.5273$	$p_1 = 2.8866$
27 Can. Maj.	$p_1 = 3.2$ years	$p_1 = 4$ years $\pm$	$\begin{cases} p_2 = 0.9981 \\ p_3 = 0.9964 \end{cases}$
Y Cygni	$p_1 = 2.9985$	$p_2 = 1.498$	.....
VV Orionis	$p_1 = 3.03$	$p_2 = 1.4854$	.....
η Orionis	$p_1 = 7.98922$	$p_1 = 7.98922$	$\begin{cases} p_2 = 1.14 \\ p_3 = 0.89 \end{cases}$

It seems probable that a good many other published periods of spectroscopic binaries are subject to the same uncertainty.

To avoid ambiguity it is necessary to make observations in as many different hour-angles as possible. For southern stars, where this cannot be done, the only solution would seem to be the combined use of data from observatories sufficiently far from one another in longitude. At present almost all spectrographic observations are concentrated on the American continent. Many doubtful cases could be solved by means of a few plates taken at some observatory in Europe or Asia. It is regrettable that there are so few observatories outside of America where

[5] Unpublished.
[6] *Astrophysical Journal*, **65**, 300, 1927.
[7] Unpublished.
[8] E. Hertzsprung, *Astronomische Nachrichten*, **198**, 15, 1914. Z. Daniel, *Publications of the Allegheny Observatory*, **3**, 182, 1915.
[9] Hagen, *Die Veränderlichen Sterne*, **1**, 623, 1920.

spectrographic observations are being made.

Erroneous periods affect materially all statistical studies of spectroscopic binaries. The mass-function and the value of $(a \sin i)$ depend directly on the period and are affected most of all. I believe, therefore, that the subject is of sufficient importance to justify a systematic investigation of the three alternative periods for all published orbits. This would be an extremely useful piece of work for an astronomer, interested in spectroscopic binaries, who has not the advantages of a large telescope for making actual observations. There can be no doubt that the work would yield many interesting results, and the information thus gained would be invaluable for all statistical studies.

I have computed below a small table showing the respective values of p_1, p_2, and p_3 expressed in sidereal days. In order to transform the published period of a spectroscopic binary (always expressed in mean solar time) into sidereal time it is usually sufficient to take:

$$p \text{ (sidereal days)} = p \text{ (mean solar days)} + 0.0027\, p.$$

With this value as argument we find from the table the corresponding alternative periods, or, where greater refinement is needed, we compute them by means of the accurate formulae. The resulting values are then transformed back into mean solar time, by subtracting 0.0027 p.

TABLE III. ALTERNATIVE PERIODS.

p_1	p_2	p_3
2.0	2.00	0.67
2.2	1.83	0.69
2.4	1.71	0.71
2.6	1.62	0.72
2.8	1.56	0.74
3.0	1.50	0.75
3.5	1.40	0.78
4.0	1.34	0.80
4.5	1.29	0.82
5.0	1.25	0.83
6.0	1.20	0.86
7.0	1.17	0.88
8.0	1.14	0.89
10.0	1.11	0.91
12.0	1.09	0.92
14.0	1.08	0.93
16.0	1.06	0.94
20.0	1.05	0.95
25.0	1.04	0.96
30.0	1.03	0.97
40.0	1.02	0.98
50.0	1.02	0.98
75.0	1.01	0.99
100.0	1.01	0.99
150.0	1.007	0.993
200	1.005	0.995
300	1.003	0.997
400	1.0025	0.9975
500	1.0020	0.9980
1000	1.0010	0.9990

YERKES OBSERVATORY, MARCH 30, 1928.

THE THREE OUTER PLANETS BEYOND NEPTUNE.

By WILLIAM H. PICKERING.

In our last paper on "The Orbit of Uranus" we mentioned the probability that besides O two other unknown planets, P and S, existed beyond Neptune, and furthermore we showed why it was unlikely that any more of large size existed beyond them, unless indeed the orbits of such planets carried them far from the plane of the ecliptic. Little more information regarding P and S will come to us from Uranus for another hundred years. Turning now to Neptune, we find that it had unfortunately already passed P by a few degrees when it was first observed as a star by Lalande in 1795, and that furthermore it will not pass it again for another hundred years, nor S for nearly two centuries. With regard to these two planets therefore, Neptune is not likely to be of much help to anyone now living. So far it has shown no other perturbation than that due to O. This it is expected will cease in about a dozen years, and it will then, as I believe, follow Newcomb's orbit as somewhat modified in "The Next Planet Beyond Neptune"* for fully thirty years without further perturbation from any unknown source.

The planet Saturn will also unfortunately be of no further use to us, unless its orbit is very materially improved, and unless by some device, still greater accuracy can be secured in its observation. The two perturbations of Uranus by P are as we have seen appreciably more marked than the one due to O, but on account of the great distance of the former unknown planet, and the comparative nearness of Saturn to the Sun, its perturbations by P are quite imperceptible, and we are left therefore with only two planetary perturbations on our hands, both of Uranus. This as is well known while sufficient to determine a circular orbit is usually quite inadequate to give us any information regarding an elliptical one. Uranus would not leave us quite so badly off as that, however, were it not for the unfortunate interference of S in the year 1812. In case P had a distinctly elliptical orbit, and S did not interfere, and if one of the perturbations due to P were much more marked than the other, we should then be able to form a distinct impression of both the eccentricity and the longitude of the perihelion of its orbit.

However, we have still another source of information to aid us in determining the elements of the orbit of P, which we believe should give us material aid in finding that planet. In 1910 the writer undertook a special study of Cometary Orbits, *Harvard Annals*, **61**, 167, and from this investigation we shall extract certain of those data which it appears may give us some information with regard to the planet. In our recent

*Popular Astronomy, **36**, 143, 218.
†Popular Astronomy, **36**, 274.

paper on the Comets of Short Period* we illustrated what has long been recognized as a fact, that the larger planets have associated with them certain groups of comets. In that paper all the known comets were classified in two ways, first into classes lettered from *A* to *H*, dependent on their aphelion distances, and second into types lettered from *N* to *R*, dependent on the proximity of their aphelia to certain great circles of the celestial sphere. All of the comets of class *A* belonged to type *N*, and were associated with the planet Jupiter. All of the comets of class *B*, except one, belonged to type *O*, and were associated with the outer planets Saturn, Uranus, Neptune, *O*, and *S*.

The next group of comets which will now particularly engage our attention in this connection belong to class *C* type *P*. The shortest aphelion distance of this class is that of comet number 253, 75.5 units, and the longest that of number 244, 210.7. It will be recalled that the longest aphelion distance of type *B* was only 59.1 units, so that the gap between the two classes is quite marked (See Figure 1). Class *A* con-

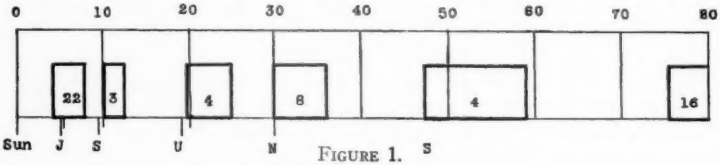


FIGURE 1.

APHELIA OF THE COMETS OF SHORT PERIOD.

tained in all 41 comets, but more than half of them have already disappeared, new ones constantly taking the places of those that had vanished. During the last quarter century only 22 comets were associated with this class. Class *B* contained 19 comets, but at least one and perhaps two have already vanished. Class *C* consists of 22 comets, 16 of which belong to type *P*. Five belong to type *Q*, and one to type *R*. Although so much more remote from the Sun, the zone associated with this planet is little more than half as wide as that of type *O*. It is, however, twice as wide as that of type *N*. Unlike the two previous types, this zone is strongly inclined to the ecliptic, as we shall presently see. Its width is 40°, and it covers one-third of the sky.

The comets of type *Q* lie in an outer zone, strongly inclined to the zone of type *P*, and as we have already seen in our previous paper includes the poles of the ecliptic. When these comets approach the Sun, and are near the intersection of these two zones, if planet *P* happens to be there at the same time, it will attract them, either increasing or diminishing their speed. In the former case their aphelion distances will be lengthened, and with these comets we have nothing to do. In the latter case their aphelia will be shortened, and thus associated with the comets of class *C*, although still belonging to type *Q*. That as many as 5 of these comets exist out of 22 indicates clearly not only the great number

*POPULAR ASTRONOMY, **36**, 274.

of comets belonging to type *Q*, but also the considerable mass and powerful influence exerted by planet *P*. The 16 remaining comets of class C type P are those in which we are especially interested, and the fact that there are so many of them, nearly as many as all those of Saturn, Uranus, Neptune, *O*, and *S* put together, also shows us that we are dealing here with a planet of considerable importance.

As compared with the comets of Jupiter's family, it must be remembered that these latter when at perihelion all pass near the Earth's orbit, and are therefore readily visible to us, while many of the perihelia of type *P* may lie far outside of the orbit of Jupiter, or even outside that of Saturn. All the known comets excepting those of class *A*, move in very eccentric orbits, and we usually think of such orbits as being necessarily associated with comets. The fact really is, however, that outside of class *A* the comets possessing these highly eccentric orbits are the only ones that can possibly come to our notice. It is quite possible, and even probable, that most of the comets of our system have orbits no more eccentric than those of the visual binary stars, or than the comets of class *A*. It is only when one of those comets of more remote aphelia is deflected in towards the Sun by an outer planet, that we can ever become aware of its existence. It is evident then that only a small proportion of the comets of type *P* can ever be visible to us.

Since the periods of some of them exceed one thousand years, it is further evident that only a small fraction of these few can have had their orbits determined as yet. Fifteen have reached us in the past ninety years, but since it is probable that some of the earlier ones were not sufficiently accurately observed to determine the elliptical character of their orbits, and that others best visible in the southern hemisphere were missed altogether, we may safely say that they are coming at the rate of fully twenty per century. It is thus evident that in the course of a comparatively few years we shall have many more active comets associated with planet *P* than the two dozen still active ones associated with Jupiter, or indeed later, than those of all the known planets taken together.

If now we admit the existence of a large unknown planet *P* revolving far outside of Neptune, then on account of its very isolation and great mass, it appears reasonable to suppose that this next remote associated group of cometary aphelia, partially shown in Figure 1, is associated with it. But before accepting this conclusion the question may naturally be asked, how do the shorter cometary aphelion distances of this group compare with the mean distance of planet *P*? The first five columns of Table I, relating to the sixteen known comets of class *C* type *P*, give in succession the catalog number, the Period of revolution, the Aphelion distance, and the Longitude and Latitude of the comet's aphelion. In our last paper on "The Orbit of Uranus"* we showed

*Popular Astronomy, **36**, 353.

TABLE I.

No.	Period	Aph.	Long.	Lat.	S
			° ′	° ′	
253	235	75.5	202 14	+ 0 31	*n*
463	279	87.9	336 01	+ 1 10	*f*
320	306	89.0	190 19	—16 30	*n*
195	367	101.0	220 39	—37 52	*n*
128	390	105.3	243 01	—47 19	*n*
271	410	109.6	96 55	+29 48	*n*
270	417	110.7	37 10	+32 50	*f*
246	500	123.9	35 28	+27 59	*f*
214	538	131.6	341 27	—28 51	*f*
351	611	142.2	238 37	—30 34	*n*
369	745	167.9	193 46	+21 12	*n*
238	782	168.9	31 06	+16 10	*f*
245	997	198.3	346 18	+13 31	*f*
375	999	198.2	285 24	—19 55	*f*
413	1001	199.2	24 20	+35 40	*f*
244	1089	210.7	283 04	—30 09	*f*

that purely from planetary perturbations there was evidence that a large planet existed whose distance was in the vicinity of 61.7 units. A little later in this paper we shall show that this distance should be extended to 67.7 units, and that in case, as is highly probable, the orbit is quite elliptical, the distance may be still further extended. By Figure 1 we see that the mean distances of the known planets coincide approximately with the minimum aphelion distances of their associated comets, and by Table I we find that the minimum aphelion distance of those comets already known of type *P* is 75.5 units, so that the two methods of determining the mean distance of the planet gives us as nearly a coincident result as might reasonably be expected.

We have already mentioned that the median plane of these cometary aphelia was strongly inclined to the ecliptic. The inclination in fact is found to be 35°.8, and assuming a direct revolution of the controlling planet, the longitude of the ascending node is 349°.8. We have explained in detail in *H.A.*, **61**, 221, exactly how these figures were obtained. In Figure 2 is shown an orthographic projection of the sphere, with longitude 350° on the farther side of its central meridian. The sixteen cometary aphelia of this class and type are plotted upon it, those on the nearer side, marked *n* in the last column of the table, being represented by circles, and those on the farther side, marked *f*, by crosses. If now we draw a line through the center in the proper direction and inclined at an angle of 36°, this line will represent the great circle above indicated. Two small circles parallel to it, and distant from it 20° on either side, show the boundaries of the zone within which all the aphelia should lie. It will be noticed that one comet, number 369, as is the case also in types *N* and *O*, furnishes an exception to this rule. However, it is classified with the other fifteen, because there is no other type save *O* to which it could belong, and its aphelion distance as is shown by Table I carries it far beyond the bounds of class *B*, and well

into class *C*. Its aphelion, however, was not used in locating the median plane.

Out of the 564 cometary orbits now catalogued, only 22 aphelion distances lie within the limits of class *C*, namely 60 to 220 units. Fifteen of these lie within the zone specified, belonging to type *P*. This zone covers one-third of the total area of the sphere. It may be shown mathematically that the chance that 15 aphelia out of 22, which are all that are definitely included in both class *C* and type *P*, should lie by accident in a zone covering but one-third of the total area of the celestial

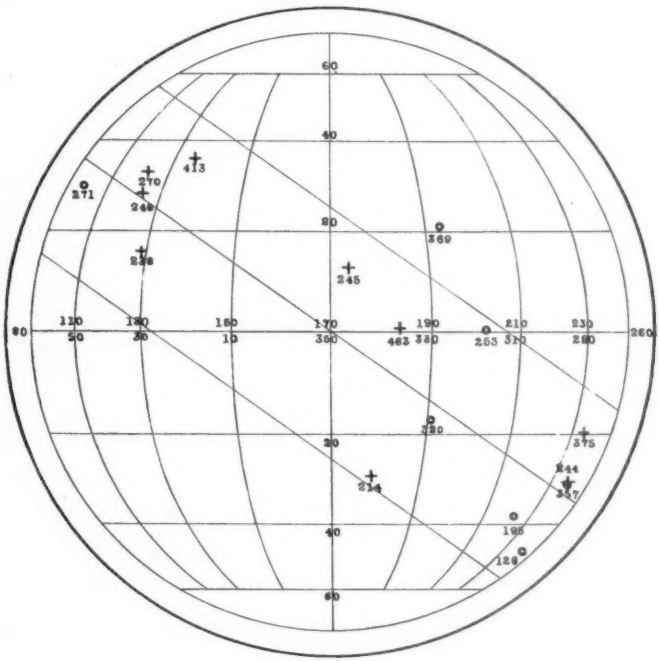


FIGURE 2.
APHELIA OF THE COMETS OF CLASS *C* TYPE *P*.

sphere is only one in many thousand. In other words a real cause of some sort is practically certain. If then the comets of class *C* are drawn in towards the Sun by the attraction of planet *P*, it appears plausible to believe that the orbit of that planet should lie near the great circle above mentioned. This then at once gives us the ascending node and inclination of the planet's orbit.

Since as we have seen in our last paper on "The Orbit of Uranus," (POPULAR ASTRONOMY, p. 360), we have not the data for computing an elliptical orbit for planet *P*, we must do the best that we can with a cir-

cular one. Using the formula given in my paper on "The Next Planet Beyond Neptune," we find that the corrections necessary to apply to the longitudes of Uranus in 1810 and in 1911, namely 222° and 297°, in order to give the longitudes of *P* on those dates, are —15°.8 and —15°.4. After applying these corrections and making use of the simple formulae of spherical trigonometry for the inclined orbit, we find that the period of *P* becomes 556.6 years, and its distance from the Sun 67.7 units, or rather more than twice as remote as Neptune. Its longitude in 1929.0 will then be 294°.4, and its latitude —30°.9. Reducing these figures to right ascension and declination we have $\alpha = 20^h\ 19^m$ and $\delta = -51°.5$. The long intervals that elapse between the returns of the comets of type *P* to the Sun indicate that few of them have been destroyed, and this fact in connection with the great distance of the planet itself, its slow motion, and the wide sweep of its orbit, perhaps explain the large number of comets associated with it, for its mass, as determined from the perturbations of Uranus, appears to be but little greater than that of Neptune, namely 1.16. Assuming the same density and albedo its visual magnitude is 11.0. It should therefore be by no means a difficult object to detect, and the fact that it has not been found before by accident is perhaps due to its far southern declination.

Its maximum perturbation of Uranus is so recent, 1911.6, and its annual rate of motion is so slow, only 0°.646, that it cannot have moved far from its computed place, even if its orbit is markedly elliptical. If its distance were as great as 80, instead of 67.7 as computed, this would make a difference of only 3° of longitude in its location in 1929. The chance of finding it therefore seems to be sufficiently good to make it worth trying, especially as all the available data are now known, and no more will be forthcoming from either Uranus or Neptune for a hundred years. Whichever is found first, planet *O* or planet *P*, the data then secured will enable us to correct the constant used in our formula for correcting the longitude, at the time of maximum deviation of the known planet. This constant is based wholly on the deviations of Uranus caused by Neptune, as compiled by Leverrier. In my earlier publication in the *Harvard Annals*, I used Bouvard's orbit of Saturn, which covered the same period, in order to furnish an additional constant dependent on the ratio of the distances of the two planets, but I later concluded that this was too uncertain to be of any real value, and rejected it.

With regard to planet *S* the associated comets are so few, only four, that little reliance can be placed on the inclination and node of its orbit, but as far as we can judge, the ascending node is in longitude 208°.7 and the inclination is 30°.6. The correction to the longitude of Uranus for a body at the distance of *S*, 48.0 units, is —13°.2, which permits us to place its longitude in 1929.0 at 344°. Assuming the doubtful figures for its node and inclination to be correct, we find that in 1929.0 its $\alpha = 22^h\ 04^m$ and its $\delta = +3°.4$. Judged by its second perturbation of

Uranus, its mass is 0.31 that of Neptune, and assuming its density and albedo to be the same as those of that planet, its visual magnitude would be 10.5. That a body of such brightness lying north of the equator should hitherto have escaped recognition, even considering its slow annual motion of 1°.10, seem improbable. We may have overestimated its brightness, but in any case we consider its location, especially its latitude, appreciably more uncertain than that of *O* or *P*. A curious numerical relation, which perhaps is not accidental, is that the periods of each of these outer planets is approximately twice that of its predecessor. Thus the period of Uranus is 84 years, that of Neptune 165, that of *S* 333, and that of *P* 557 to 656, depending on whether we determine its distance by means of Uranus, or by its associated comets.

Regarding planet *O*, which has not yet been found, it may be remarked that it is much more likely to deviate from its suggested place in latitude than it is in longitude. Its longitude was computed by a method very direct, fully explained, and readily followed in my first paper, and it is very unlikely to be far out of the way. The latitude on the other hand, as stated in both of my former papers, was merely estimated, or in other words assumed on evidence insufficient for computation, as was done also for Neptune at the time of its discovery.

The reason for this was simply that our present observations are not sufficiently accurate to render it possible to compute the latitude. The effect of a neighboring planet in that coördinate is too small. Neptune's orbit like those of the inner planets deviates but slightly from the plane of the ecliptic. It is quite possible that that of *O* is more inclined as eccentric orbits often are, and the planet may at present be even as much as 5° or 6° from the ecliptic. It is exceedingly improbable that any such large deviation exists in the case of the longitude. Six degrees as seen from the Sun would correspond to 45° as seen at aphelion from Neptune, if at a distance of 5 units. As pointed out in my first paper, Neptune appears, according to Greenwich, to have been drawn slightly to the south of its computed latitude ever since 1904. This may perhaps be due to *O*. At present it is 0°.5 north of the ecliptic.

But there is still another cause which may explain in part why the planet has not yet been found. Its mass being three-quarters that of the Earth, it seemed reasonable to consider its density as nearly identical. I then assumed its albedo to be the same. This was much less probable, since we have no information whatever on this matter. The Earth has so much snow and cloud that it must be reckoned as a bright planet. Planet *O* for aught we know to the contrary may have no clouds or atmosphere at all to speak of, it may even be a cold solid mass of meteoric iron, with an exceedingly small albedo. While this does not seem at all probable, to take an intermediate case I have selected the planet Mars as a standard for comparison, taking the density as before. Mars is a better planet for this purpose than the Earth, since not only is its albedo more certain, but it also enables us to give the photographic

as well as the visual magnitude. Its albedo is 0.15, and that of Neptune 0.52. Neptune therefore has 22.88 times the mass, 78.9 times the bulk, 18.4 times the surface, and reflects 63.8 times the light of *O*. The visual magnitude of Neptune is 7.65 and that of *O* therefore 12.2, while its photographic magnitude, taking the color of Mars as nearly identical with those of Aldebaran, Betelgeux, and Antares, is **13.5**.[1] This is 1.7 of a magnitude fainter than the visual one given in my previous paper. The planet is now going behind the Sun, and it is therefore unlikely that it will be found before next winter. If those who have searched unsuccessfully for it would publish a list of the places examined, and the magnitudes of the faintest stars shown on their plates, it might save a considerable unnecessary duplication of labor. In case the investigation appears to be a rather large one, it might be shared between two or more observatories.

PRIVATE OBSERVATORY, MANDEVILLE, JAMAICA, B. W. I., MAY 5, 1928.

NOTE ADDED JUNE 30.

In addition to the three unknown planets above mentioned, there appears to be a rather massive unknown satellite to Saturn, whose period is a trifle over 23 years.—W.H.P.

OCCULTATIONS FOR AUGUST AND SEPTEMBER.

By WM. CLETUS DOYLE, S. J.

Observation of occultations would be an easy matter if it were not for the tedious labor of making predictions for them. True we can tell the time within ten minutes or so by consulting the *Ephemeris,* but one will not be tempted to repeat such a process after just one experience of spending ten anxious minutes with his eye fixed to a telescope. Now the accompanying maps give all the necessary data to a sufficiently close degree of accuracy. The question is: Is it worth while editing such maps for the whole United States for stars down to the sixth magnitude? In order to test out their usefulness, predictions for all the immersions occurring at the dark limb of the moon during August and September are given on four maps. If you are interested in having these maps continued, please write and let us know.

All four of these stars are invisible to the naked eye, but there should be little difficulty in observing them even with a small telescope. On the charts the lines marked 8, 8:10, 10:20, etc., indicate the Central Standard Time for the places through which they pass. By estimating the proportional distances of your place from two of these lines you will

[1] In close confirmation of this result Professor King in the *H.A.*, **59**, 265, states that the difference between the visual and photographic magnitudes of Mars is 1.33.

find the time of immersion within one or two minutes. The other lines give the angular distances of the occultation from either the north or south point of the moon. For instance, N60E means 60° east of the north point; S20E means 20° east of the south point. (The north point is the point on the circumference of the lunar disk nearest to the north pole of the heavens.)

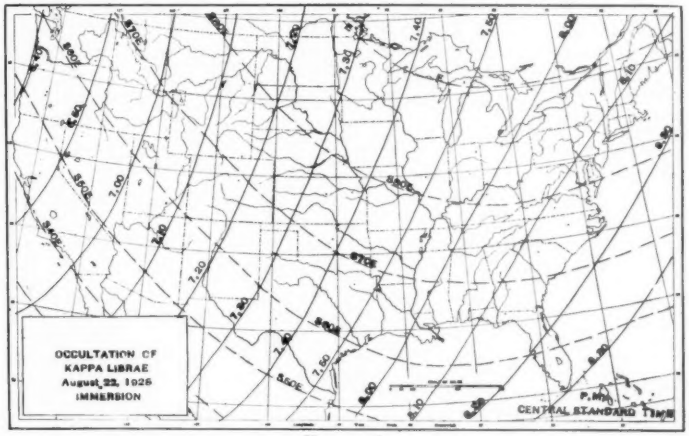


FIGURE 1.

August 22. Kappa Librae (Magnitude: 5.0). Time of immersion varies from 6:40 P.M. on the North Pacific Coast to 8:30 P.M. in Florida. Will be lost in twilight in the West.

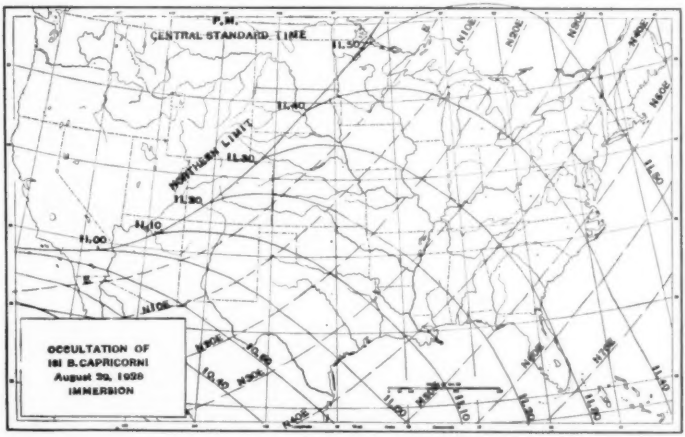


FIGURE 2.

August 29. 161 B. Capricorni (6.4). Time of immersion varies

from 10:50 P.M. in Mexico to 11:50 in Maine. The northern limit (north of which there will be no occultation) runs from Southern California to west of Lake Superior.

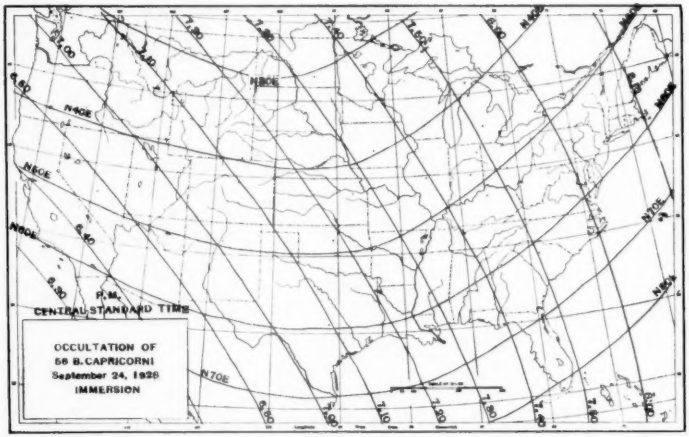


FIGURE 3.

September 24. 56 B. Capricorni (6.3). Immersion varies from 6:30 P.M. in Southern California to 8:30 P.M. in Maine. Will be lost in twilight in West.

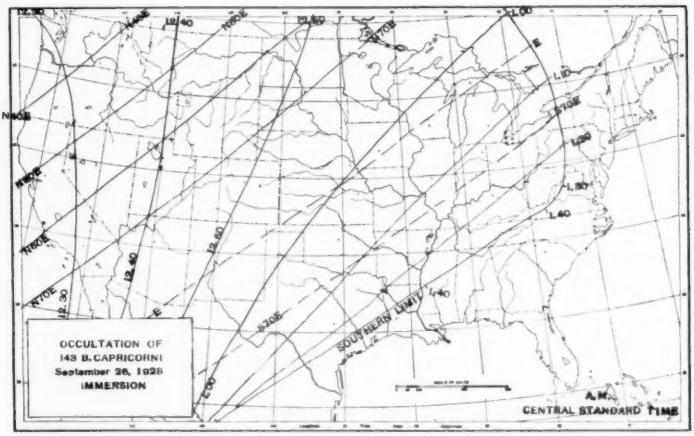


FIGURE 4.

September 26. 143 B. Capricorni (6.1). Immersion varies from 12:30 A.M. on the Pacific Coast to 1:40 A.M. in the southeastern United States. Will be too near the horizon to observe in East.

CREIGHTON UNIVERSITY OBSERVATORY, OMAHA, NEBRASKA.

PLANET NOTES FOR SEPTEMBER AND OCTOBER.

By CLIFFORD E. SMITH.

The *Sun* will be moving southeast from the central part of Leo to the eastern edge of Virgo. On September 23 the sun will be at the Autumnal Equinox which marks the beginning of fall. The position of the sun on September 1, October 1, and October 31 will be respectively: R.A. $10^h\,40^m$, Decl. $+8°\,28'$; R.A. $12^h\,28^m$, Decl. $-3°\,0'$; and R.A. $14^h\,20^m$, Decl. $-13°\,58'$.

The phases of the *Moon* will occur as follows:

Last Quarter	Sept.	6 at	5 P.M.	C.S.T.
New Moon		13 "	7 P.M.	"
First Quarter		21 "	9 P.M.	"
Full Moon		29 "	7 A.M.	"
Last Quarter	Oct.	5 "	11 P.M.	"
New Moon		13 "	10 A.M.	"
First Quarter		21 "	3 P.M.	"
Full Moon		28 "	5 P.M.	"

The moon will be at perigee (nearest the earth) on September 4, October 1, and October 30, and at apogee (farthest from the earth) on September 20 and October 17.

Mercury, early in September, will be at the eastern border of Leo. During this period it will move to the central part of Virgo. The apparent motion will be direct (easterly among the stars) until October 12, thereafter the apparent motion will be retrograde. Mercury will be in conjunction with Venus twice during this period, once on September 10 and again on October 1. On October 1 the two planets will set about an hour and a half after the sun. Mercury will be at greatest elongation east on September 30 and at inferior conjunction October 24.

Venus, at the beginning of this period, will be near the western border of Virgo, and during September and October it will move across Libra and Scorpio to the western part of Ophiuchus. Early in October it will set about an hour and a half after the sun. Venus will be in conjunction with Mercury on September 10 and on October 1.

Mars, during the early part of September, will be in the central part of Taurus. By the end of October, however, it will have moved to the western part of Gemini. It will be in quadrature west of the sun on September 14. Thus it will be near the meridian at sunrise during the middle of September.

Jupiter will be in the southern part of Aries about midway between the two bright stars α Arietis and α Ceti. By the end of October it will be near the meridian at midnight since it will be in opposition with the sun on October 29. Its apparent motion during this period will be retrograde.

Saturn will be in the southern part of Ophiuchus. Early in September it will be near the meridian at sunset since it will be in quadrature east of the sun on September 5.

Uranus will be in the southern part of Pisces. It will be found near the meridian at midnight late in September. It will be in opposition with the sun on September 28.

Neptune will be in Leo about a degree south of Regulus (α Leonis). It will be a morning object near the sun. Early in October it will rise about two hours before the sun.

Occultations Visible at Washington.

[From the *American Ephemeris.*]

Date 1928		Star's Name	Magnitude	IMMERSION. Washington C.T.	Angle from N	EMERSION. Washington C.T.	Angle from N	Duration
				h m	°	h m	°	h m
Sept. 6	ω	Tauri	4.8	0 46	121	1 21	189	0 35
6	53	Tauri	5.3	1 54	49	3 0	259	1 7
9	*A*	Geminorum	5.1	1 38	93	2 32	258	0 55
18	28	Librae	6.2	18 13	83	19 23	316	1 11
22	φ	Sagittarii	3.3	17 49	107	19 19	253	1 30
24	56	B. Capricorni	6.3	20 55	59	22 18	257	1 23
28	336	B. Aquarii	6.3	2 40	114	3 14	182	0 34
Oct. 2	145	B. Arietis	6.5	3 5	39	4 16	264	1 11
4	103	Tauri	5.5	4 27	31	5 24	301	0 57
9	η	Leonis	3.6	4 29	121	5 40	276	1 10
11	ν	Virginis	4.2	4 58	113	6 3	299	1 5
18	151	G. Ophiuchi	6.0	16 55	156	17 43	218	0 48
19	69	G. Sagittarii	6.3	19 28	356	19 30	352	0 3
30	247	B. Tauri	5.8	19 50	81	20 42	235	0 52
31	31	τ Tauri	4.3	2 49	83	4 5	247	1 16

VARIABLE STARS.

Maxima of Variable Stars of Short Period.

[Calculated by members of the classes in Astronomy at Carleton College.]

Given to the nearest hour in Greenwich civil time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of Maxima in 1928							
					Sept.				Oct.			
	h m	° ′		d h	d	h	d	h	d	h	d	h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7			26	17				
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 01.7	6	8	22	15	8	22	21	3
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	10	8	21	10	8	0	24	14
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	9	0	23	19	8	14	23	10
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	5	20	19	18	10	14	24	12
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	4	4	19	19	5	9	20	23
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	11	6	27	15	14	1	30	11
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	9	10	22	7	9	11	22	8
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	8	20	20	0	1	3	23	9
RX Aurigæ	4 54.5	+39 49	7.2— 8.1	11 15.0	11	2	22	17	4	8	27	14
SX Aurigæ	5 04.6	+42 02	8.0— 8.7	1 12.8	7	18	20	0	8	9	20	16
SY Aurigæ	05.5	+42 41	8.4— 9.5	10 03.3	7	17	28	0	8	3	28	10
Y Aurigæ	21.5	+42 21	8.6— 9.6	3 20.6	8	3	23	14	9	0	24	11
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	6	13	23	3	9	17	26	7
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	9	17	24	21	10	0	25	3
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3			22	11			19	11
RT Aurigæ	23.0	+30 33	5.1— 6.0	3 17.5	5	14	20	12	5	10	20	8
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	5	17	21	13	7	9	23	5
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	4	9	24	16	4	20	25	3

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900		Decl. 1900		Magnitude	Approx. Period		Greenwich civil times of Maxima in 1928							
								Sept.				Oct.			
	h	m	°	′		d	h	d	h	d	h	d	h	d	h
RU Camelop.	7	10.9	+69	51	8.5— 9.8	22	06.5			16	18	8	21	31	0
RR Gemin.	7	15.2	+31	04	10.0—11.5	0	09.5	7	19	23	16	9	13	25	11
V Carinæ	8	26.7	—59	47	7.4— 8.1	6	16.7	8	10	21	19	5	5	25	7
T Velorum	8	34.4	—47	01	7.6— 8.5	4	15.3	8	14	22	12	6	10	20	8
V Velorum	9	19.2	—55	32	7.5— 8.2	4	08.9	9	4	17	22	5	10	22	22
Z Leonis	9	46.4	+27	22	7.9— 9.6	56	08.7	2	2					28	10
RR Leonis	10	02.1	+24	29	9.1—10.1	0	10.9	8	3	21	17	9	19	23	9
SU Draconis	11	32.2	+67	53	8.9— 9.6	0	15.8	7	6	20	11	10	7	23	12
S Muscæ	12	07.4	—69	36	6.4— 7.3	9	15.8	7	21	27	5	6	20	26	4
SW Draconis		12.8	+70	04	8.8— 9.6	0	13.7	8	7	19	17	6	19	23	21
T Crucis		15.9	—61	44	6.8— 7.6	6	17.6	7	9	20	21	11	1	24	12
R Crucis		18.1	—61	04	6.8— 7.9	5	19.8	5	4	22	15	4	6	21	19
S Crucis	12	48.4	—57	53	6.5— 7.6	4	16.6	9	23	24	0	8	2	26	20
W Virginis	13	20.9	—	2 52	8.7—10.4	17	06.5			16	15	3	21	21	4
SS Hydræ		25.0	—23	08	7.4— 8.1	8	04.8	7	7	23	17	10	3	26	12
RV Urs. Maj.	13	29.4	+54	31	9.2— 9.9	0	11.2	8	23	27	16	7	1	25	18
ST Virginis	14	22.5	—	0 27	10.3—11.4	0	09.9	2	17	19	4	5	14	22	0
V Centauri		25.4	—56	27	6.4— 7.8	5	11.9	7	11	23	23	4	22	21	10
RS Bootis	14	29.3	+32	11	8.9—10.0	0	09.1	5	7	20	9	5	11	20	13
R Trian. Austr.	15	10.8	—66	08	6.7— 7.4	3	09.3	8	5	21	18	8	17	22	6
S Trian. Austr.	15	52.2	—63	29	6.4— 7.4	6	07.8	4	23	23	22	6	14	25	13
S Normæ	16	10.6	—57	39	6.6— 7.6	9	18.1	4	9	23	21	3	15	23	3
RW Draconis		33.7	+58	03	9.6—10.8	0	10.6	9	18	23	1	6	8	19	15
RV Scorpii	16	51.8	—33	27	6.7— 7.4	6	01.5	5	23	24	3	6	6	24	11
X Sagittarii	17	41.3	—27	48	4.4— 5.0	7	00.3	6	6	20	7	4	7	18	8
Y Ophiuchi		47.3	—	6 07	6.1— 6.5	17	02.9			17	6	4	10	21	12
W Sagittarii	17	58.6	—29	35	4.3— 5.1	7	14.3	7	1	22	6	7	10	22	15
Y Sagittarii	18	15.5	—18	54	5.4— 6.2	5	18.6	7	23	19	23	6	21	24	4
U Sagittarii		26.0	—19	12	6.5— 7.3	6	17.9	7	23	21	11	4	23	18	10
Y Scuti		32.6	—	8 27	8.7— 9.2	10	08.3	5	13	26	6	6	14	27	7
RZ Lyræ		39.9	+32	42	9.9—11.2	0	12.3	9	7	24	15	9	23	25	7
RT Scuti		44.1	—10	30	9.1— 9.7	0	11.9	1	17	16	13	8	21	23	18
κ Pavonis	18	46.6	—67	22	3.8— 5.2	9	02.2	3	17	21	22	10	2	28	6
U Aquilæ	19	24.0	—	7 15	6.2— 6.9	7	00.6	6	22	20	23	5	1	26	2
XZ Cygni		30.4	+56	10	8.6— 9.3	0	11.2	8	4	22	4	6	4	20	4
U Vulpec.		32.2	+20	07	6.5— 7.6	7	23.5	8	14	24	13	10	13	26	12
SU Cygni		40.8	+29	01	6.2— 7.0	3	20.3	7	12	19	1	8	7	19	19
η Aquilæ		47.4	+	0 45	3.7— 4.5	7	04.2	9	9	23	17	8	2	22	10
S Sagittæ		51.5	+16	22	5.6— 6.4	8	09.2	5	18	22	12	9	7	26	1
X Vulpec.	19	53.3	+26	17	9.5—10.5	6	07.7	6	1	18	15	7	14	20	6
X Cygni	20	39.5	+35	14	6.0— 7.0	16	09.3	4	7	20	17	7	2	23	11
T Vulpec.		47.2	+27	52	5.5— 6.1	4	10.5	8	2	21	9	9	3	22	10
UY Cygni		52.3	+30	03	9.6—10.4	0	13.5	8	13	19	18	6	14	23	10
RV Capric.		55.9	—15	37	9.2—10.1	0	10.7	6	22	20	9	8	7	21	17
TX Cygni	20	56.4	+42	12	8.5— 9.7	14	17.4	7	17	22	10	7	3	21	20
VY Cygni	21	00.4	+39	34	8.8— 9.5	7	20.6	2	13	18	6	3	23	19	16
SW Aquarii		10.2	—	0 20	9.9—10.8	0	11.0	8	20	22	15	6	10	20	5
VZ Cygni	21	47.7	+42	40	8.2— 9.2	4	20.7	6	8	20	22	10	9	24	23
Y Lacertæ	22	05.2	+50	33	9.1— 9.6	4	07.8	7	3	24	11	7	10	24	17
δ Cephei		25.5	+57	54	3.7— 4.6	5	08.8	9	1	19	19	5	21	22	0
Z Lacertæ		36.9	+56	18	8.2— 9.0	10	21.1	10	14	21	11	2	8	24	3
RR Lacertæ		37.5	+55	55	8.5— 9.2	6	10.1	4	3	23	9	6	5	25	11
V Lacertæ		44.5	+55	48	8.5— 9.5	4	23.6	7	19	22	18	7	17	22	15
X Lacertæ	22	45.0	+55	54	8.2— 8.6	5	10.7	9	18	20	15	6	23	23	7
SW Cassiop.	23	03.7	+58	11	9.2— 9.7	5	10.6	6	10	22	18	9	1	19	23
RS Cassiop.		32.6	+61	52	9.0—11.0	6	07.1	7	16	20	7	9	4	21	18
RY Cassiop.	23	47.2	+58	11	9.3—11.8	12	03.4	8	1	20	5	2	8	26	14

Minima of Variable Stars of Short Period.

[Calculated by members of the classes in Astronomy at Carleton College.]

Given to the nearest hour in Greenwich civil time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of Minima in 1928							
					Sept.				Oct.			
	h m	° ′		d h	d h		d h		d h		d h	
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8	9 5				14 3			
RT Sculptor.	31.5	—26 13	9.6—10.5	0 12.3	6 20		21 3		5 11		19 18	
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	3 7		18 16		3 16		18 15	
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	7 9		19 14		7 22		20 3	
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	8 21		20 7		7 11		24 14	
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	9 13		23 6		6 22		20 15	
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	7 2		22 8		6 16		25 19	
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	3 1		18 23		4 20		20 17	
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6	3 12				5 20			
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	6 5		23 12		2 1		19 8	
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	5 20		23 16		5 14		23 10	
λ Tauri	55.1	+12 12	3 3— 4.2	3 22.9	9 21		25 16		11 12		27 7	
RW Tauri	3 57.8	+27 51	7.1— [11	2 18.5	7 6		23 20		2 4		18 18	
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	5 19		23 13		5 10		23 4	
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	6 3		19 8		2 13		28 23	
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	9 0		21 14		10 12		23 2	
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	9 22		22 8		4 18		29 14	
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	7 10		18 12		5 2		21 16	
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	9 21		20 18		7 2		23 11	
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	8 3		20 4		8 5		20 6	
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	4 10		23 22		6 22		19 22	
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	8 6		23 21		9 12		25 2	
SV Gemin.	54.6	+24 28	9.8— [11	4 00.2	7 6		23 7		1 7		17 8	
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	2 17		19 22		7 2		24 7	
U Columbæ	6 11.2	—33 03	9.2—10.0	2 19.2	5 7		17 19		6 12		18 23	
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	3 5		16 21		7 9		21 1	
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	8 1		23 7		8 13		23 19	
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	1 1		25 11		7 16		19 21	
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	7 14		21 22		6 6		20 14	
R Can. Maj.	7 14.9	—16 12	5.8— 6.4	1 03.3	9 4		22 19		6 11		20 2	
RY Gemin.	21.7	+15 52	8.9— [10	9 07.2	3 18		22 8		10 23		29 13	
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	9 16		22 21		6 3		19 8	
TX Gemin.	30.3	+17 08	10.0—11.9	2 19.2	9 11		26 6		13 1		29 20	
RR Puppis	43.5	—41 08	9.4—10.7	6 10.3	6 14		19 10		8 17		21 14	
V Puppis	7 55.4	—48 58	4.1— 4.8	1 10.9	3 23		18 12		10 8		24 21	
X Carinæ	8 29.1	—58 53	7.9— 8.7	0 13.0	3 11		17 12		8 15		22 17	
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	9 19		28 18		8 6		27 5	
RX Hydræ	9 00.8	— 7 52	9.1—10.5	2 06.8	6 16		24 22		4 1		22 8	
S Velorum	29.4	—44 46	7.8— 9.3	5 22.4	4 10		22 5		4 2		21 21	
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	5 16		19 4		9 9		22 21	
RR Velorum	10 17.8	—41 36	10.0—10.9	1 20.5	8 9		23 5		8 1		22 21	
SS Carinæ	54.2	—61 23	12.2—12.8	3 07.2	2 11		22 6		5 11		25 6	
RW Urs. Maj.	10 35.4	+52 34	10.3—11.4	7 07.9	5 8		20 1		12 0		26 16	
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	7 22		21 12		5 2		18 16	
RZ Centauri	12 55.6	—64 05	8.5— 8.9	1 21.0	3 21		18 21		3 21		18 22	
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.1	9 1		23 11		7 20		22 5	
SS Centauri	07.2	—63 37	8.8—10.4	2 11.5	2 19		17 16		2 13		17 10	
SX Hydræ	13 39.0	—26 23	8.6—12.7	2 21.5	6 15		18 5		5 14		22 23	
δ Libræ	14 55.6	— 8 07	4.8— 6.2	2 07.9	9 1		23 0		6 23		20 23	
U Coronæ	15 14.1	+32 01	7.6— 8.7	3 10.9	13 6		27 2		10 21		24 16	
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.4	9 14		26 10		4 20		21 16	
SS Libræ	15 43.4	—15 14	9.3—11.5	0 18.4	8 23		23 8		7 17		22 2	

Minima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich civil times of Minima in 1928					
					Sept.				Oct.	
	h m	° ′		d h	d h	d h	d h	d h	d h	d h
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	6 20	21 12	6 4	20 21		
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	5 13	24 2	6 11	25 1		
R Aræ	31.1	—56 48	6.8— 7.9	4 10.2	5 14	23 7	2 3	19 20		
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1		19 22	1 16	22 10		
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	9 15	23 6	6 20	20 11		
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	1 16.2	4 18	18 4	8 1	21 17		
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	3 18	22 5	4 12	22 23		
TX Herculis	15.4	+42 00	8.3— 9.0	2 01.4	9 13	21 21	10 10	22 19		
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	8 13	23 7	8 1	22 19		
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	6 9	21 2	10 17	25 11		
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	7 12	20 16	3 21	23 16		
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	6 5	27 22	8 18	30 10		
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	6 11	22 11	8 10	24 9		
WX Sagittarii	53.6	—17 24	9.2—10.8	2 03.1	6 9	19 4	8 8	21 2		
WY Sagittarii	17 54.9	—23 01	9.5—10.6	4 16.0	7 22	21 22	5 23	24 15		
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	7 1	22 13	8 1	23 13		
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	3 5	17 17	9 11	23 23		
V Serpentis	11.1	—15 34	9.5—11.1	3 10.9	5 18	19 13	10 6	24 2		
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2	14 13	29 18	14 22	30 3		
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	2 22	18 8	3 18	19 4		
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	5 12	23 7	11 1	28 20		
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	6 18	23 9	10 0	26 14		
RR Draconis	40.8	+62 34	9.3—13	2 19.9	5 0	22 0	8 23	25 23		
RS Scuti	43.7	—10 21	9.3—10.3	0 15.9	3 20	19 19	5 18	21 16		
β Lyræ	46.4	+33 15	3.4— 4.1	12 21.8	1 9	27 4	10 2	23 0		
U Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	8 10	23 17	8 23	24 6		
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	5 22	21 2	6 5	21 8		
RV Lyræ	12.5	+32 15	11. —12.8	3 14.4	8 10	22 20	7 5	21 15		
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	2 6	20 4	8 2	26 0		
U Sagittæ	14.4	+19 26	6.5— 9.0	3 09.1	8 0	21 11	5 0	18 13		
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	8 8	23 2	7 19	22 13		
TT Lyræ	24.3	+41 30	9.4—11.6	5 05.8	6 11	22 5	7 22	22 16		
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	9 1	25 8	3 11	19 19		
SY Cygni	19 42.7	+32 28	10. —12	6 00.2	7 7	19 7	7 8	19 8		
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	5 1	24 22	4 21	24 18		
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	7 3	25 10	4 13	22 13		
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	6 0	22 20	9 17	26 14		
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	9 13	23 3	6 17	20 6		
UW Cygni	19.6	+42 55	10.5—13	3 10.8	4 19	25 12	9 7	23 3		
V Vulpec.	32.3	+26 15	8.2— 9.8	37 19.0	1 17					
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	8 13	27 18	7 9	26 15		
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	7 4	20 23	4 18	18 13		
Y Cygni	48.1	+34 17	7.1— 7.9	2 23.9	9 5	21 4	9 4	21 3		
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	6 2	20 8	4 14	18 21		
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	10 3	20 6	10 10	20 13		
RY Aquarii	21 14.8	—11 14	8.8—10.4	1 23.2	11 1	22 20	10 13	22 8		
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3		21 15		22 23		
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	6 4	21 9	6 15	21 20		
RW Lacertæ	22 40.6	+49 08	10.2—11.2	5 04.4	6 21	22 10	7 23	23 13		
VW Pegasi	22 51.7	+32 42	10.0—10.6	5 06.4	10 6	20 20	6 16	22 13		
Y Piscium	23 29.3	+ 7 22	9.0—12.0	3 18.4	9 17	24 18	9 20	24 20		
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	11 2	24 6	10 18	23 3		

Monthly Report of the American Association of Variable Star Observers, for the Months of May and June, 1928.

This report includes, for the first time, observations received from our first two members from Germany, Messrs. Beyer and Ahnert, and we gladly welcome them to our ranks. Both of these men are experienced observers and their contributions to our columns are an added value to our results.

Sr. Dartayet, formerly of Buenos Aires, Argentina, has gone to the National Observatory at La Plata as computer, where he will have the coöperation of Dr. Dawson, whose report appears herewith for the first time in several years.

The recent meeting held at Vassar on June 1 and 2 was a huge success from beginning to end. More than fifty members and their friends were present, and they kept arriving from early on Friday afternoon until during the banquet on the evening of the 2nd. They came from great distances, for example young Clinton Ford was there from Ann Arbor, Michigan, and Charles H. Lee, from St. Petersburg, Florida, not to fail to mention the group of four young men from the Lehigh University at Bethlehem, Pennsylvania. New York City and state were, of course, well represented, as well as the girls' colleges in Massachusetts.

President Pickering was at his best and carried both Council and Business meetings through with expedition. Plans were formulated for considerable printing and reprinting of our various publications. Twenty new members were elected, besides the inclusion in the class of Sustaining Members of some twenty members already listed in other classes. These are to be known as the "Old Guard," and represent the back-bone of the Association, financially and otherwise.

The following slate was presented by the Nominating Committee, to be voted upon at the October meeting:

M. J. Jordan, Boston, Massachusetts.
Wm. Henry, Brooklyn, New York.
C. W. Elmer, New York City, New York.
Alice H. Farnsworth, Mt. Holyoke, Massachusetts.

The Annual Meeting will be held at Harvard Observatory on October 20. The next Spring Meeting is scheduled to be held in May, 1929, in Washington, D. C.

Dr. Furness gave the meetings a splendid account of the 1927 English eclipse, one actually seen by her and others, and the Recording Secretary gave an informal paper dealing with the classes of Long Period Variables, and their distribution in the sky.

President McCracken was the guest of honor and in his afterdinner address even surpassed his splendid talk of seven years ago, when we first met at Vassar.

Many of our members will be in attendance, either directly or indirectly as representatives of the Association, at the Leiden meeting of the I.A.U. in July. President Pickering is to address the British Astronomical Association at its June meeting. Professor Anne S. Young is to spend the next year visiting observatories on the west coast, and incidentally will do what she can, while there, to urge the prompt publication of our circulars, catalogues, etc.

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1928.

April 0 = J.D. 2425337; May 0 = J.D. 2425367; June 0 = J.D. 2425398.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
V SCL	— CAS	R FOR	R TAU	R RET	R CAE
000339	004746b	*022426*	042209	*043263*	*043738*
316[12.6 Bl	352 10.8 Pt	316 10.0 Bl	307 10.6 Bg	353 12.2 Ht	347 12.2 Bl
356[13.3 Bl	W CAS	336 10.5 Bl	311 10.7 Bg	353 11.8 Bl	350[11.7 En
S SCL	004958	343 10.7 Bl	321 11.0 Bg	358 12.2 Ht	352 12.2 Dw
001032	352 11.8 Pt	353 11.3 Bl	325 11.1 Bg	356 12.2 En	353 12.0 Bl
316 11.5 Bl	U TUC	W PER	330 11.6 Bg	366 12.4 Dr	353 12.3 Ht
356 12.7 Bl	*005475*	024356	341 11.7 Bg	X CAM	358 12.3 Ht
T CAS	316 12.0 Bl	352 9.3 Pt	344 12.6 Lh	043274	364[12.0 Bl
001755	317 11.2 Sm	R HOR	347 12.0 Bf	307 12.4 Br	R PIC
338 8.5 Wk	320 11.8 En	*025050*	352 13.7 Pt	319 12.9 Br	*044349*
342 9.6 Wk	325 11.2 En	309 6.5 Bl	W TAU	320 12.8 Br	309 7.0 Bl
347 10.7 Wk	328 12.0 Bl	314 6.8 Ht	042215	325 12.9 Br	314 7.1 Ht
352 9.4 Pt	336 11.5 Bl	316 6.7 Bl	352 9.5 Pt	326 12.9 Br	316 6.5 Bl
358 10.8 Wk	343 10.6 Bl	317 6.9 Sm	S TAU	329 12.9 Br	317 7.3 En
378 8.1 Wk	353 9.9 Bl	320 6.6 En	042309	342 11.5 Wk	325 7.5 En
379 8.9 Jo	355 10.3 Sm	325 7.1 En	307[13.9 Bg	343 12.1 Br	326 7.6 Ht
381 8.5 Jo	364 9.3 Bl	326 7.0 Ht	311[13.9 Bg	346 11.8 Br	328 6.5 Bl
408 8.5 Jo	RU CAS	329 7.1 En	321 15.3 Bg	346 11.5 Wy	334 7.5 Ht
S TUC	010564	334 7.1 Ht	325[14.8 Bg	347 11.4 Wk	336 7.4 Bl
001862	241 5.8 Fu	336 7.5 Bl	330[14.3 Bg	352 11.2 Pt	339 7.5 Dr
309 9.5 Bl	U SCL	339 7.7 Dr	341[12.8 Bg	354 11.4 Br	343 7.7 Bl
316 9.6 Bl	*010630*	343 7.7 Bl	347[14.8 Bf	358 11.3 Wk	346 7.7 Ht
317 9.7 Sm	320[13.2 Bl	346 8.2 Ht	T CAM	360 11.2 Br	350 7.7 Dw
317 9.7 En	356[13.2 Bl	351 7.9 En	043065	361 11.2 Br	350 7.7 En
325 9.8 En	X CAS	353 8.6 Ht	342 11.3 Wk	363 10.8 Br	350 7.7 Dr
336 10.2 Bl	014958	353 7.9 Bl	343 10.9 Br	370 10.1 Br	353 8.4 Ht
343 10.5 Bl	352 10.1 Pt	355 8.1 Sm	344 11.4 Wk	370 9.7 B	353 7.8 Bl
353 11.0 Bl	355 11.3 Bn	358 8.8 Ht	346 10.7 Br	378 8.3 Wk	356 8.5 En
364 12.6 Bl	374 11.2 Bn	364 8.7 Bl	347 10.6 Sw	389 8.0 Wk	358 7.9 Sm
T PHE	385 11.4 Bn	T HOR	352 10.2 Pt	R DOR	358 8.6 Ht
002546	RR ORI	*025751*	353 10.0 Lg	*043562*	364 8.5 Bl
309 9.0 Bl	015023	317[12.2 Sm	354 10.2 Br	309 6.0 Bl	365 8.8 Ht
316 9.6 Bl	244 6.4 Fu	320 13.0 Bl	358 9.5 Wk	314 5.2 Ht	TT TAU
336 10.5 Bl	256 6.1 Fu	347[12.7 Bl	359 10.0 An	316 5.8 Bl	044528
343 11.1 Bl	U PER	355[12.2 Sm	360 9.8 Br	317 5.6 Sm	307 8.7 Br
356 12 5 Bl	015254	U ARI	361 9.8 Br	317 5.5 En	308 8.7 Br
W SCL	352 8.2 Pt	030514	363 9.7 Br	325 5.6 En	319 8.7 Br
002833	W AND	307 13.7 Bg	370 9.4 Br	326 5.5 Ht	320 8.7 Br
320 13.0 Bl	021143a	311 13.6 Bg	378 9.5 Wk	328 6.0 Bl	321 8.7 Br
356 13.0 Bl	327 7.5 Ch	321 13.1 Bg	379 9.1 Sw	334 5.4 Ht	325 8.7 Br
Y CEP	T PER	325 13.0 Bg	389 8.8 Wk	336 6.1 Bl	326 8.8 Br
003179	021258	330 12.8 Bg	SZ TAU	343 6.0 Bl	335 8.7 Br
345 12.3 Wk	330 8.8 Ch	AA PER	043118	346 5.5 Ht	343 8.8 Br
α CAS	352 8.6 Pt	030846	323 6.7 Fu	350 5.8 En	AB AUR
003455	o CET	307 9.9 Br	R RET	353 5.5 Ht	044930b
239 2.6 Fu	*021403*	308 9.9 Br	*043263*	353 6.2 Bl	244 7.3 Fu
256 2.6 Fu	322 9.0 Ch	319 10.1 Br	309 9.8 Bl	355 5.8 Sm	257 7.2 Fu
267 2.6 Fu	S PER	325 10.2 Br	314 10.4 Ht	356 5.5 En	266 7.2 Fu
283 2.6 Fu	021558	Y PER	316 10.3 Bl	358 5.6 Ht	R ORI
323 2.6 Fu	330 9.2 Ch	032043	317 11.4 Sm	364 6.2 Bl	045307
X SCL	344 9.7 Kl	352 9.6 Pt	317 10.4 En	365 5.6 Ht	344 12.3 Lh
004435	352 8.7 Pt	R PER	325 11.2 En	R CAE	— AUR
320[13.2 Bl	R CET	032335	326 11.2 Ht	*043738*	045443
356[13.2 Bl	*022000*	352 11.9 Pt	328 11.2 Bl	316 12.3 Ht	261 3.2 Fu
RV CAS	327 10.0 Ch	353 11.2 Lg	334 11.4 Ht	317[12.0 Sm	323 3.4 Fu
004746a	R FOR	T TAU	336 11.5 Bl	320 13.0 Bl	R LEP
352 9.4 Pt	*022426*	041619	346 11.8 Ht	326 12.3 Ht	*045514*
	309 9.4 Bl	362 10.2 By	350 12.2 En	346 12.1 Ht	330 9.4 Ch

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1928.

J.D. Est. Obs.

R LEP
045514
352 7.5 Pt

W ORI
050001
256 7.7 Fu
261 7.4 Fu
267 7.6 Fu
285 7.5 Fu
296 7.6 Fu
342 6.7 Go

V ORI
050003
352 13.6 Pt
353 13.5 Lg

T LEP
050022
309 8.9 Bl
316 8.9 Bl
336 10.1 Bl
343 9.9 Bl
347 10.2 Bf
353 10.3 Bl
364 10.5 Bl

S PIC
050848
317[12.9 Sm
320[13.4 Bl
325[12.9 En
347[13.4 Bl
350[12.2 En
356[12.9 En
358[12.9 Sm

AE AUR
050934
342 5.6 Go
343 5.6 Go
347 5.6 Go

R AUR
050953
342 9.5 Sw
352 9.3 Pt
353 9.8 Ch
357 10.7 Pi
379 11.4 Sw

T PIC
051247
309 12.8 Bl
316 13.1 Ht
317 12.5 Sm
320 14.0 Bl
325[12.5 En
347[13.1 Bl
350[13.3 Dw
353[13.1 Ht
358 13.3 Ht
358 13.3 Sm
361 12.6 Dr

T COL
051533
310 10.8 Bl
314 11.0 Ht
316 11.0 Bl
317 11.2 Sm
317 11.0 En
325 11.4 En
326 11.7 Ht
328 11.5 Bl
334 11.7 Ht
336 11.3 Bl
343 11.0 Bl
346 11.6 Ht
350 11.1 Dw
350 11.2 Dr
350 12.4 En
353 11.0 Bl
353 11.6 Ht
355 11.4 Sm
357 11.2 En
358 11.5 Ht
362 11.2 Sm
364 11.0 Bl

S AUR
052034
352 8.3 Pt
353 9.1 Ch
357 9.1 Sp
370 8.9 B
374 9.2 Sp

W AUR
052036
349 8.4 L
352 8.2 Pt
353 9.0 Ch
357 9.0 Pi
362 9.1 By
370 8.8 B
371 9.3 By

RR CAM
052372
307 10.4 Br
319 10.5 Br
320 10.6 Br
325 10.5 Br
326 10.6 Br
329 10.7 Br
343 10.7 Br
354 10.6 Br
360 10.6 Br
361 10.6 Br
363 10.5 Br
370 10.3 Br

CI ORI
052401
299 7.2 Fu
342 5.1 Go
343 5.1 Go

T ORI
053005a
346 10.1 An
346 10.2 L
352 9.8 Pt
358 10.1 An
361 10.1 B

AN ORI
053005t
346 11.0 L

S CAM
053068
342 9.6 Wk
347 9.3 Wk
352 8.4 Pt
358 9.3 Wk
367 8.3 Wk
374 8.3 Wk
387 8.7 Wk

RR TAU
053326
311 13.6 Bg
316 13.2 Bg
321 12.4 Bg
325 12.1 Bg
330 12.8 Bg
332 12.8 Bg
341 13.6 Bg
347 13.7 Bf
352 13.8 Bg
353 13.4 Bg
354 13.3 Bg

RU AUR
053337
352 12.6 Pt
357[11.2 Pi

U AUR
053531
352 12.2 Pt
358[12.7 Ch

SU TAU
054319
329 9.8 Ch
344 9.7 Lh
346 9.4 An
347 9.8 Lg
352 9.6 Pt
353 9.9 Lg
357 9.7 Sp
359 9.8 Ch
368 9.7 Pt
374 9.6 Pt
375 9.7 Sp
376 9.7 Pt
378 9.6 Pt

S COL
054331
310 11.3 Bl
316 11.5 Bl
316 11.6 Ht
317 11.6 Sm
317 11.6 En
325 11.6 En
326 11.6 Ht
328 11.7 Bl
334 11.8 Ht
336 11.9 Bl
343 11.9 Bl
346 12.4 Ht
353 12.8 Ht
353 12.0 Bl
355 12.6 Sm
358 12.6 Ht
364 12.8 Bl

Z TAU
054615a
316 13.3 Bg
325 13.7 Bg
332 13.8 Bg
347 13.9 Bf
353 13.7 Bg

RU TAU
054615c
316 12.7 Bg
325 12.7 Bg
330 12.7 Bg
341 12.6 Bg
347 12.7 Bf
353 12.7 Bg
360 12.6 Bf

R COL
054629
310 9.2 Bl
316 9.7 Bl
316 9.9 Ht
317 9.3 Sm
317 9.9 En
325 10.3 En
326 10.3 Ht
328 10.4 Bl
334 10.9 Ht
336 10.7 Bl
343 11.6 Bl
346 11.7 Ht
350 11.7 En
353 11.8 Bl
353 12.0 Ht
355 11.7 Sm
356 12.4 En
358 12.4 Ht
362 12.0 Sm
364 12.4 Bl

α ORI
054907
239 1.2 Fu
256 1.2 Fu
260 1.1 Fu
266 1.1 Fu

α ORI
054907
267 1.1 Fu
270 0.9 Fu
276 1.0 Fu
283 0.9 Fu
323 0.8 Fu

U ORI
054920a
344 11.4 Lh
352 11.6 Pt
359 11.6 Ch

Z AUR
055353
307 10.8 Br
308 10.9 Br
319 10.6 Br
320 10.5 Br
322 10.5 Br
325 10.4 Br
326 10.4 Br
329 10.4 Br
343 10.1 Br
343 9.8 Ch
346 10.0 Br
352 9.8 Pt
353 9.9 Pt
353 9.9 Ch
354 10.0 Pt
355 10.0 Pt
356 10.1 Pt
357 9.7 Pi
362 9.7 By
363 9.7 B
363 9.9 Lh
368 9.9 Pt
371 10.0 By
372 10.0 Pt
374 9.9 Pt
375 10.0 Pt
376 10.1 Pt
377 10.3 By
378 10.4 Pt

R OCT
055686
310 11.2 Bl
316 11.0 Bl
328 10.6 Bl
330 10.0 En
336 10.0 Bl
343 9.0 Bl
350 7.0 En
353 7.5 Bl
356 6.6 En
358 7.0 Sm
364 6.8 Bl

X AUR
060450
346 11.2 Ch
350 10.9 B

X AUR
060450
352 10.0 Pt
353 10.9 Ch
358 10.5 Ch
371 9.5 B

V AUR
061647
361 10.3 B
374 10.6 Sp
378 10.5 Lh
378 10.5 B

V MON
061702
352 11.7 Pt
361[11.1 Ch

— AUR
062047
346 10.5 An
346 10.6 L
359 10.3 An
359 10.3 L

U LYN
063159
349 13.7 Lh
349 13.7 B
379[13.1 B

R MON
063308
352 11.7 Pt

NOV PIC
063462
314 7.0 Ht
320 6.8 En
326 7.1 Ht
328 6.8 En
334 7.0 Ht
346 7.1 Ht
350 7.1 En
353 7.1 Ht
356 7.1 En
358 7.0 Sm
358 6.9 Ht
365 7.1 Ht

S LYN
063558
329 10.4 Ch
349 8.9 B
349 8.5 Lh
352 8.8 Pt
357 8.7 Pi
368 8.8 B

X GEM
064030
355 11.1 Bn
357 11.9 GC
357 11.4 Sp
365 12.1 B
372 11.3 Bn

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
W MON	R VOL	Z PUP	W PUP	V CNC	T CNC
064707	*070772*	*072820b*	*074241*	081617	085120
352 10.5 Pt	326 13.4 Ht	316 8.4 Bf	328 9.1 Bl	344 11.9 Br	328 9.9 Ch
Y MON	346 13.4 Ht	316 8.4 Bg	336 9.1 Bl	352 12.1 Pt	352 8.6 Pt
065111	352 13.2 Dw	321 8.7 Bg	343 9.5 Bl	359 12.2 Ch	T PYX
349 12.7 Lg	352 13.3 Dr	325 8.9 Bg	346 9.6 Ht	374 12.3 B	*090031*
350 12.1 B	353 13.4 Ht	325 8.7 Bf	350 10.4 En	374 12.5 Lh	320 [u Bl
359 12.1 Ch	356 13.4 En	330 9.0 Bg	353 10.4 Ht	380 11.5 Sw	347 [u Bl
360 12.4 Lg	358 13.0 Ht	341 9.2 Bg	354 10.5 Bl	RT HYA	V UMA
373 11.5 Lg	358 13.4 Sm	347 9.3 Bf	356 10.6 En	*082405*	090151
X MON	361 13.2 Dr	348 9.5 Bf	358 10.5 Sm	352 8.3 Pt	357 10.3 Pi
065208	L_2 PUP	354 9.7 Bf	358 11.0 Ht	R CHA	359 10.1 L
307 7.9 Br	*071044*	354 9.4 Bg	365 11.6 Bl	*082476*	374 10.3 B
319 7.7 Br	339 4.4 Dr	360 9.6 Bf	T GEM	310 8.4 Bl	374 10.5 Lh
320 7.7 Br	RR MON	S VOL	074323	316 8.2 Bl	398 11.0 B
325 7.7 Br	071201	*073173*	347 11.8 Ch	317 8.4 Sm	W CNC
326 7.8 Br	349 11.5 Lg	310 10.1 Bl	358 11.4 Ch	317 8.0 En	090425
329 7.7 Br	353 12.0 Lg	314 9.8 Ht	U PUP	326 8.4 En	347 9.8 Lg
343 7.6 Br	356 11.8 Ch	316 9.4 Bl	*075612*	328 8.2 Bl	348 10.2 L
361 7.6 Ch	359 11.8 Lg	317 9.4 En	350 13.8 B	336 8.2 Bl	350 9.0 B
R LYN	361 10.0 Jn	326 9.5 En	358[12.5 Ch	343 8.4 Bl	355 8.4 Wk
065355	372 12.8 Lg	326 9.2 Ht	R CNC	350 8.3 En	359 8.2 Lg
357[11.5 Pi	V GEM	328 9.0 Bl	081112	353 8.5 Bl	369 8.5 Wk
V CMI	071713	334 9.0 Ht	329 7.2 Ch	356 8.9 En	374 8.4 B
070109	349 8.7 Lg	336 9.1 Bl	342 6.4 Wk	358 9.7 Sm	374 8.5 Lh
329[11.2 Ch	349 8.6 B	339 9.1 Dr	347 6.4 Wk	364 8.9 En	380 9.2 Al
349[13.3 Lg	352 8.8 Pt	343 9.0 Bl	351 5.9 Ch	U CNC	389 8.8 Wk
350[13.5 B	360 8.4 Lg	346 8.9 Ht	352 6.4 Pt	083019	RS CNC
359[13.0 Ch	363 8.4 By	350 9.2 En	358 6.5 Wk	347 13.0 Lg	090431
360[13.0 Lg	368 8.7 B	352 9.0 Dw	360 7.2 Fd	350 13.7 B	246 6.5 Fu
372[14.0 Lg	371 8.5 By	352 9.1 Dr	366 6.6 Ah	356 13.8 Lg	262 6.0 Fu
R GEM	372 8.4 Lg	353 9.1 Bl	369 6.6 Fd	374 13.1 GC	266 6.0 Fu
070122a	377 8.9 By	353 9.0 Ht	370 6.5 Fd	381 11.9 GC	285 6.2 Fu
346 10.3 Ch	U MON	356 8.9 En	370 6.1 B	X UMA	323 6.6 Fu
347 10.7 Sw	*072609*	358 9.0 Ht	373 7.2 Fd	083350	RW CAR
352 10.9 Pt	246 5.8 Fu	358 8.9 Sm	374 7.3 Fd	352 12.9 Pt	*091868*
355 10.9 Wd	260 6.2 Fu	361 9.0 Dr	374 5.9 Wk	357[11.5 Pi	320[12.8 Bl
357 11.1 Sp	266 6.6 Fu	364 9.2 Bl	375 7.6 Fd	377[13.4 B	326[12.8 En
380 12.4 Al	283 6.2 Fu	365 9.4 Ht	376 7.6 Fd	S HYA	347[12.8 Bl
Z GEM	296 6.0 Fu	366 9.0 Dr	379 7.2 Fd	084803	352 13.2 Dw
070122b	323 6.3 Fu	U CMI	391 6.9 Wk	328 11.1 Ch	357 12.8 En
352 12.4 Pt	S CMI	073508	Z CAM	347 11.4 Wk	361[12.8 Dr
355[10.9 Wd	072708	345 9.7 Wk	081473	347 12.5 Lg	Y VEL
362[10.8 Wd	328 10.0 Ch	350 10.5 B	346 11.5 An	352 12.5 Pt	*092551*
TW GEM	347 10.6 Ch	352 10.5 Pt	346 11.3 L	356 13.0 Lg	310 9.3 Bl
070122c	352 10.4 Pt	359 10.1 An	355 12.0 L	358 12.4 Ch	316 9.7 Bl
352 7.8 Pt	356 10.8 Ch	359 9.8 L	359 11.5 L	358 11.1 Wk	317 9.5 Sm
R CMI	360 10.8 Fd	368 9.6 B	362 11.1 L	365 12.6 B	320 9.5 En
070310	365 11.4 B	S GEM	V CNC	374 13.0GC	326 9.9 En
349 11.2 Lg	379 11.1 Fd	073723	081617	386 12.7 B	328 9.6 Bl
359 10.9 L	380 12.2 Al	358 13.1 Ch	307 9.8 Br	X CNC	336 10.0 Bl
359 11.0 An	386 11.9 B	365 12.9 B	310 10.5 Br	084917	339 10.2 Dr
360 10.9 Lg	T CMI	W PUP	320 10.7 Br	377 6.9 By	343 10.1 Bl
367 10.3 Lh	072811	*074241*	322 10.7 Br	T HYA	351 10.4 En
367 10.2 B	349 11.4 Lg	310 9.8 Bl	325 10.8 Br	*085008*	352 10.7 Dr
372 10.5 Lg	352 11.8 Pt	314 9.4 Ht	326 10.9 Br	347 12.8 Lg	352 10.6 Dw
386 9.9 B	357 11.5 Sp	316 9.5 Bl	328 11.0 Ch	352 12.6 Pt	353 10.3 Bl
R VOL	360 11.7 Lg	320 9.4 En	329 11.1 Br	356 13.1 Lg	358 10.4 Sm
070772	373 12.3 Lg	325 9.3 En	343 11.8 Br	358[12.5 Ch	361 10.9 Dr
316 13.4 Ht		326 9.4 Ht	343 10.8 Sw		364 10.9 Bl

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1928.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
R CAR			Y DRA			R LEO			Z VEL			S CAR			R UMA		
092962			093178			094211			*094953*			*100661*			103769		
310	5.6	Bl	347	12.0	Lg	355	10.2	Gt	353	12.3	Ht	356	6.0	En	363	8.0	B
314	5.8	Sm	349	11.9	Wk	355	9.9	Wd	353	12.5	Bl	356	5.9	Dw	364	7.8	Fd
314	5.6	Ht	358	11.8	Wk	355	10.1	An	357	12.5	En	357	6.0	Sm	365	7.8	Fd
317	5.0	Bl	374	13.1	Wk	355	9.5	Wk	358	12.8	Sm	358	5.5	Ht	369	8.3	Fd
320	5.0	En	387	13.2	Wk	357	9.9	Fd	358	12.3	Ht	361	5.6	Dr	371	8.2	By
324	4.7	Dr	R LMI			357	10.0	Jo	361	12.5	Dr	364	5.5	Bl	371	8.4	Wd
326	5.2	Ht	093934			360	9.6	Fd	364	12.6	Bl	365	5.5	Ht	372	7.9	Fd
326	4.7	Dr	330	10.4	Ch	360	10.3	Ch	V LEO			366	6.0	Dr	373	8.2	Fd
328	4.9	Bl	345	9.5	Wk	362	10.4	Wd	095421			Z CAR			374	8.4	Fd
328	4.5	Dr	352	7.7	Pt	365	10.0	Fd	352	13.4	Pt	*101058*			374	8.1	Wk
329	4.5	En	354	7.9	GC	369	9.8	Fd	354	13.4	GC	317[	12.3	Sm	374	7.9	Pt
331	4.5	Dr	354	7.6	Ch	369	9.8	Wk	355	12.7	Wk	320[	12.6	Bl	375	8.2	Fd
333	4.4	Dr	355	7.6	Wk	370	9.9	Fd	376	13.3	GC	326	12.3	En	378	8.1	Fd
334	5.0	Ht	357	7.4	Jo	372	10.0	Fd	377	13.0	Lh	347[	12.6	Bl	379	8.1	Fd
336	4.4	Dr	365	7.4	Fd	373	9.9	Fd	377	13.2	B	352[	12.3	En	379	8.3	Sw
336	4.4	Bl	368	7.0	Wk	374	10.0	Fd	379	12.7	Wk	356	14.0	Dr	379	7.8	Al
339	4.3	Dr	372	7.1	Fd	375	10.1	Fd	379	13.4	GC	358[	12.3	Sm	379	8.0	Eb
343	4.6	Bl	373	7.0	Fd	376	10.3	Fd	RV CAR			361[	12.6	Dr	379	8.0	Kz
346	4.6	Ht	374	6.8	Fd	376	10.5	GC	*095503*			W VEL			379	8.1	Jo
350	4.8	En	374	7.5	GC	378	10.2	Wd	317	11.9	Bl	*101153*			381	8.0	Jo
352	4.7	Dw	375	6.9	Fd	378	10.2	Fd	320	11.8	Bl	310	9.6	Bl	387	8.1	Wk
352	4.5	Dr	378	6.7	Fd	379	10.2	Fd	328	11.6	Bl	317	9.6	Bl	391	8.7	B
353	4.4	Ht	378	7.0	Wb	379	10.2	Jo	336	10.7	Bl	317	9.8	Sm	408	8.6	Jo
353	4.7	Bl	379	6.6	Fd	379	9.9	Al	339	10.9	Dr	328	10.0	Bl	409	9.4	Gy
356	4.4	En	379	7.0	Jo	379	10.5	GC	343	10.3	Bl	330	10.2	En	V HYA		
357	4.6	Sm	379	6.5	Al	379	10.2	Kz	353	10.3	Bl	336	10.0	Bl	*104620*		
358	4.1	Ht	379	7.2	GC	379	10.3	Eb	354	10.9	En	343	10.6	Bl	310	8.7	Bl
361	4.7	Dr	379	6.8	Kz	381	10.2	Pi	356	10.7	Dr	351	11.1	En	317	9.2	Bl
364	4.7	Bl	379	6.9	Eb	381	10.2	Jo	356	10.9	Dw	353	10.5	Bl	328	9.0	Bl
365	4.9	Ht	381	7.2	Pi	383	10.2	Wk	360	10.7	En	357	11.1	En	328	9.7	Ch
366	5.2	Dr	381	6.5	Jo	387	10.3	Wk	361	11.0	Dr	358	11.1	Sm	336	9.7	Ch
X HYA			383	7.0	Wk	388	10.3	B	364	10.7	Bl	364	11.0	Bl	336	8.9	Bl
093014			387	7.0	Wk	X LEO			RY LEO			U HYA			343	8.9	Bl
321	12.7	Bg	388	7.3	B	094512			095814			*103212*			345	9.6	Ch
325	12.5	Bg	410	7.8	Gy	346[	13.9	L	342	9.1	Kl	324	5.2	Fu	348	8.4	L
330	12.5	Bg	RR HYA			348[	13.9	L	344	8.8	Kl	346	4.7	L	351	9.6	Ch
341	12.2	Bg	*094023*			Y HYA			345	8.7	Kl	348	4.7	L	352	8.8	Pt
347	12.2	Bf	348	13.9	Lg	*094622*			346	8.7	Kl	359	5.3	L	353	8.8	Bl
347	12.1	Lg	359	13.0	Lg	348	6.8	Lg	359	9.0	Kl	RZ CAR			360	9.4	Ch
349	11.9	B	373	12.8	Lg	352	6.4	Pt	S CAR			*103270*			362	9.7	An
349	12.0	Lh	R LEO			359	7.0	Lg	*100661*			356	13.7	Dw	364	9.0	Bl
354	11.9	Bg	094211			373	7.1	Lg	310	7.7	Bl	356	13.8	Dr	RS HYA		
355	11.8	Wk	242	7.5	Fu	Z VEL			314	8.0	Sm	361	13.7	Dr	*104628*		
356	12.0	Lg	262	7.5	Fu	*094953*			314	7.5	Ht	R UMA			310	11.8	Bl
358	11.4	Ch	266	7.6	Fu	316	12.8	Ht	317	7.5	Bl	103769			317	11.6	Bl
359	11.7	Bg	271	8.3	Fu	317	12.8	Sm	320	7.4	En	327	9.0	Ch	328	10.9	Bl
371	11.5	B	284	8.4	Fu	320	12.8	En	326	7.0	Ht	342	8.4	Wk	336	10.7	Bl
373	11.2	Lg	294	8.7	Fu	320	12.9	Bl	328	6.9	Bl	343	8.3	Sw	343	10.2	Bl
374	11.0	Wk	299	8.9	Fu	326	12.5	En	329	7.0	En	347	8.1	Gy	353	10.2	Bl
376	11.7	Lh	319	9.6	Fu	326	12.8	Ht	334	6.9	Ht	347	8.0	Wy	359	10.3	Lg
391	9.7	Wk	324	9.5	Fu	328	12.6	Bl	336	6.4	Bl	347	7.8	Wk	364	9.9	Bl
Y DRA			329	10.0	Jn	334	12.5	Ht	339	6.5	Dr	355	8.6	Wd	W LEO		
093178			330	9.7	Ch	336	12.4	Bl	343	6.2	Bl	357	7.7	Jo	104814		
307	10.1	Br	342	9.4	Wk	343	12.5	Bl	346	6.0	Ht	358	7.8	Wk	321	14.0	Bg
319	10.4	Br	346	9.9	An	346	12.3	Ht	350	5.8	En	360	8.4	Fd	325	13.9	Bg
320	10.4	Br	347	9.5	Wk	351	12.5	En	353	5.2	Bl	360	7.8	Ch	355	10.3	Wk
325	10.9	Br	352	9.2	Pt	352	12.6	Dw	353	5.8	Ht	362	8.2	Wd	359	13.4	Bg
344	11.8	Wk	354	10.2	GC	352	12.4	Dr	356	5.6	Dr	363	7.9	Lh	359	14.2	Lg

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
W LEO	X CEN	T VIB	T CVN	T UMA	S UMA
104814	*114441*	*120905*	122532	123160	123961
359 14.2 Lg	336 9.2 Bl	357 11.0 Fd	378 10.0 Wk	381 8.5 Jo	355 9.0 Wd
377 13.0 B	343 9.8 Bl	359 11.5 Lg	379 9.5 Al	383 8.2 Wk	355 8.8 An
379 12.6 Wk	353 10.1 Bl	360 11.2 Fd	379 9.7 Eb	387 8.3 Wk	357 8.5 Jo
RS CAR	365 10.7 Bl	R CRV	379 9.7 Kz	389 8.6 Ah	358 8.9 Wk
110361	W CEN	*121418*	381 9.8 Pi	393 8.3 Ah	362 8.9 Wd
314[12.3 Sm	*115058*	309 8.9 Bf	391 9.4 Wk	395 8.6 Ah	362 8.6 Ah
326[12.1 En	310 11.1 Bl	325 8.0 Bf	Y VIR	397 8.6 Ah	363 8.8 Lh
357[12.3 Sm	316 11.7 Ht	344 8.4 Wk	*122803*	398 8.7 B	363 8.6 B
S LEO	317 11.5 Bl	346 8.1 An	309 9.4 Bf	407 9.2 Pc	369 8.4 GC
110506	317 12.2 Sm	346 7.8 L	316 9.2 Bf	408 8.8 Jo	369 8.9 Wk
348 10.9 Lg	320 12.2 En	349 8.0 Wk	325 9.9 Bf	R VIR	371 8.7 Wd
353 10.9 GC	326 12.6 En	352 7.8 Pt	337 11.2 Bf	123307	374 8.2 Pt
355 10.3 Wk	326 12.4 Ht	355 8.3 Wd	346 11.4 L	344 11.2 Wk	374 8.6 Wy
359 10.2 Lg	328 12.0 Bl	357 8.2 Jo	348 11.8 Bf	352 10.0 Pt	375 8.0 Jo
361 10.1 Ch	334 12.5 Ht	358 8.4 Wk	348 11.5 Lg	354 10.0 Wk	379 8.6 Eb
363 11.0 Cl	336 12.5 Bl	362 8.3 Wd	353 12.4 GC	357 9.3 Jo	379 8.7 Kz
369 10.1 GC	346 12.8 Ht	363 8.4 Lh	359 12.4 Bg	364 9.0 Wk	379 8.4 GC
374 10.2 Wk	347 13.1 Bl	363 8.2 B	359 12.3 Lg	366 8.8 Ah	379 8.4 Al
376 10.2 GC	351 12.2 En	363 8.4 Cl	362 12.4 An	378 8.0 Wd	379 8.3 Pi
378 9.9 B	357 12.2 Sm	373 8.5 Wd	376 13.7 GC	378 8.3 B	379 8.0 Jo
379 10.0 GC	Z UMA	374 8.7 Wk	U CEN	379 8.3 Wk	379 8.1 B
379 10.0 Eb	115158	374 8.7 Cl	*122854*	379 8.3 Eb	381 8.0 Jo
379 10.0 Kz	296 7.2 Fu	374 8.9 B	347 11.3 Bl	379 8.1 Kz	383 8.7 Wk
389 10.2 Wk	R COM	374 8.9 Lh	353 10.6 Bl	380 8.1 Jo	387 8.3 Wk
RY CAR	115919	378 8.9 Wd	365 10.0 Bl	381 8.3 Jo	389 8.2 Ah
111561	333 9.6 Ch	379 8.7 Jo	T UMA	383 8.2 Ah	393 8.2 Ah
310 11.1 Bl	344 8.7 Wk	379 9.2 Kz	123160	389 7.6 Ah	395 8.1 Ah
317 11.9 Bl	348 8.8 Lg	379 9.0 Eb	327 10.2 Ch	391 7.6 Wk	397 7.7 Ah
320 11.1 Bl	349 8.8 Wk	381 8.7 Jo	338 8.4 Wk	393 7.3 Ah	398 7.8 B
328 11.8 Bl	352 8.5 Pt	385 9.2 B	341 9.2 Ch	397 7.0 Ah	407 8.0 Pc
336 11.8 Bl	358 8.4 Ch	387 9.8 Wk	342 8.0 Wk	RS UMA	408 7.6 Jo
343 12.0 Bl	358 8.6 Wk	398 9.5 B	344 8.6 Ah	123459	Y CVN
353 12.3 Bl	359 8.8 Lg	408 10.6 Jo	344 9.0 Lh	309 10.1 Bf	124045
356 12.6 Dr	363 8.3 Cl	— UMA	345 8.5 Kl	316 10.3 Bf	347 6.0 Go
364 12.6 Bl	365 8.3 B	121664	346 8.5 Kl	325 10.9 Bf	349 6.2 Go
366 12.8 Dr	374 8.8 Wk	343 7.5 Go	346 8.4 Ah	331 11.1 Ch	RU VIR
RS CEN	379 9.2 Wy	347 7.5 Go	347 9.3 Wk	337 11.4 Bf	124204
111661	379 8.1 Eb	348 7.8 Go	348 8.4 Ah	348 12.2 Bf	349 13.0 Lh
314 12.1 Sm	379 8.3 Kz	353 7.8 Go	353 8.4 GC	359 12.9 Bg	349 12.9 B
317 12.4 Bl	380 8.4 Jo	354 7.8 Go	355 8.4 Wd	374 13.1 Pt	352 13.1 Pt
320 11.2 Bl	381 8.7 Pi	355 7.8 Go	357 8.3 Jo	379 13.4 B	359 12.8 Lg
328 10.6 Bl	381 8.5 Jo	357 7.8 Go	358 8.2 Wk	379 13.4 Al	376 13.2 GC
335 9.4 En	387 9.5 Wk	359 8.0 Go	362 8.4 Ah	S UMA	379 13.2 GC
336 9.1 Bl	SU VIR	360 8.0 Go	362 8.8 Wd	123961	U VIR
339 8.9 Dr	120012	363 7.8 Go	363 8.5 Lh	327 10.5 Ch	124606
343 8.5 Bl	348 13.9 Lg	368 8.0 Go	363 8.6 B	329 10.6 Jo	344 9.3 Wk
351 8.4 En	357 12.4 B	SS VIR	369 8.2 Wk	341 9.2 Ch	352 9.5 Pt
353 8.4 Bl	357 12.4 Lh	122001	369 8.3 GC	342 10.2 Wk	354 10.2 Wk
356 8.2 Dr	358 12.5 Ch	348 7.9 L	371 8.3 Wd	344 8.9 Ah	359 9.9 Lg
357 8.0 En	359 12.9 Lg	362 9.0 An	374 8.7 Wy	344 8.9 Lh	361 11.1 B
357 8.0 Sm	376 11.9 Lg	378 8.1 B	374 8.3 Pt	345 9.2 Kl	364 9.9 Wk
364 7.9 Bl	379 11.8 Kz	T CVN	379 8.0 Kz	346 9.1 Kl	379 11.2 Eb
366 8.2 Dr	379 11.9 Eb	122532	379 8.0 Eb	346 9.2 An	379 11.0 Kz
X CEN	381 11.8 Pi	333 9.9 Ch	379 8.2 GC	346 9.0 Ah	379 10.8 Al
114441	T VIR	352 9.5 Pt	379 7.9 Al	347 9.1 Kl	379 11.3 Wk
310 8.6 Bl	*120905*	356 10.0 Lh	379 8.6 Pi	347 9.3 Wk	391 12.0 Wk
317 8.6 Bl	348 11.0 Lg	357 9.9 B	379 8.5 Jo	348 9.0 Ah	
328 8.8 Bl	352 11.4 Pt	378 9.7 Fd	379 8.6 B	353 8.6 GC	

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RV VIR	S VIR	RT CEN	Z BOO	R CEN	R CAM
130212	*132706*	*134236*	140113	*140959*	142584
391 13.5 B	379 6.7 Kz	360 12.4 En	359 9.4 Wk	366 6.1 Dr	367 7.9 B
U OCT	379 6.6 Jo	361 11.7 Dr	359 9.2 Br	U UMI	375 8.2 Gb
131283	381 6.8 Al	365 11.2 Ht	360 9.2 Br	141567	375 8.3 Wk
310 11.7 Bl	381 6.2 Jo	365 11.4 Bl	368 8.8 B	345 10.8 Wk	379 8.0 Kz
316 12.6 Ht	389 6.6 Wk	R CVN	370 9.3 Br	346 11.6 Ch	379 8.1 Eb
317 12.9 Sm	408 6.8 Jo	134440	378 10.1 Wk	355 10.5 Wk	383 8.3 B
317 12.5 Bl	RV CEN	333 10.3 Ch	379 9.4 B	363 11.9 Cl	389 8.3 Wk
320 12.9 En	*133155*	342 8.9 Wk	379 10.2 Eb	369 11.9 Wk	R BOO
326 12.9 Ht	310 8.2 Bl	347 10.1 Wk	379 10.0 Kz	374 11.5 Pt	143227
347 13.8 Bl	317 8.2 Bl	352 8.9 Pt	391 10.2 Wk	379 10.7 Kz	327 8.5 Ch
356 13.6 Dw	328 8.6 Bl	356 9.1 Ch	Z VIR	379 10.5 Eb	338 9.0 Wk
356 13.5 Dr	336 8.0 Bl	358 9.8 Wk	*140512*	381 10.3 Jo	342 9.4 Wk
358[13.2 Sm	343 7.9 Bl	375 8.7 Wk	350 11.1 B	380 10.4 Jo	349 9.3 Wk
366[13.2 Dr	353 7.8 Bl	379 9.1 Eb	364 10.7 Wk	381 10.8 Al	351 9.9 Ch
V VIR	365 7.8 Bl	379 9.0 Kz	375 11.3 Sp	383 10.9 B	352 9.9 Pt
132202	T UMI	379 8.7 Pi	379 11.2 Eb	384 10.8 Wk	354 9.8 B
359 11.5 Lg	133273	389 8.7 Wk	379 11.1 Kz	S BOO	355 9.5 Wk
377[13.6 Lh	358 13.2 Wk	410 8.1 Gy	379 10.9 B	141954	366 11.0 Wk
R HYA	T CEN	RX CEN	379 11.3 Wk	347 13.1 Ch	368 10.3 B
132422	*133633*	*134536*	386 11.0 B	354 12.8 B	376 11.0 B
310 8.7 Bl	310 5.9 Bl	320 12.4 Bl	391 11.4 Wk	355 12.9 L	376 11.2 Lh
317 8.5 Sm	316 5.9 Ht	328 11.0 Bl	RU HYA	355 12.7 Wk	379 11.7 Wk
317 9.0 Bl	317 5.7 Bl	336 9.8 Bl	*140528*	355 13.3 An	381 11.5 Pi
325 9.3 En	326 6.2 En	343 9.5 Bl	310 10.5 Bl	355 12.9 Gt	391 11.8 Wk
327 9.4 Ch	326 5.9 Ht	353 9.6 Bl	317 10.7 Bl	359 13.0 Ch	V LIB
328 9.2 Bl	328 6.0 Bl	365 10.4 Bl	325 11.0 En	374 12.4 Pt	*143417*
332 9.0 En	332 6.3 En	T APS	328 11.2 Bl	378 11.8 B	354[13.5 B
336 9.2 Bl	334 6.5 Ht	*134677*	332 11.2 En	378 11.7 Lh	383 13.0 B
343 8.8 Bl	336 6.0 Bl	317[12.7 Sm	336 11.2 Bl	384 11.8 Wk	U BOO
345 9.3 Ch	339 6.2 Dr	321[13.2 Bl	343 11.8 Bl	RS VIR	144918
348 8.9 L	343 6.0 Bl	328[11.7 En	353 12.2 Bl	142205	350 10.3 B
352 9.0 Pt	346 6.6 Ht	347 12.6 Bl	353 12.5 En	309 10.3 Bf	380 11.6 Al
353 9.2 En	353 6.8 Bl	351 11.7 En	355 12.2 Sm	316 10.1 Bf	381 11.2 GC
353 9.1 Bl	353 7.2 En	353 12.2 Bl	360 12.0 En	325 11.0 Bf	381 11.0 Pi
355 8.8 Sm	353 7.4 Ht	357 12.3 En	362 12.4 Sm	337 11.4 Bf	383 10.9 B
360 9.0 En	356 7.2 Dr	358 12.3 Sm	R CEN	348 11.5 Bf	Y LUP
361 9.1 Ch	358 7.8 Ht	365 10.8 Bl	*140959*	350 12.1 B	*145254*
362 8.7 Sm	358 7.6 Sm	RR VIR	310 7.6 Bl	359 11.6 Bg	317[12.4 Sm
S VIR	360 7.8 En	*135008*	316 6.8 Ht	388 12.9 B	321[13.7 Bl
132706	361 7.4 Dr	352 11.8 Pt	317 6.9 Sm	V BOO	329[12.4 En
317 10.1 Sm	365 8.1 Ht	377 13.2 B	317 7.1 Bl	142539a	347[13.7 Bl
327 9.7 Ch	365 7.8 Bl	377 13.0 Lh	320 6.9 En	346 10.6 Ch	353[12.8 En
345 9.7 Ch	RT CEN	Z BOO	325 6.3 En	352 10.8 Pt	362[12.4 Sm
352 8.7 Pt	*134236*	140113	326 6.1 Ht	354 10.5 B	366[13.7 Dr
355 8.7 Sm	310 11.8 Bl	307 11.1 Br	328 6.1 Bl	359 10.4 Wk	S APS
355 8.3 Wk	316 11.7 Ht	319 10.0 Br	334 5.7 Ht	360 10.7 Fd	*145971*
357 8.3 Sp	317 11.7 Bl	320 9.7 Br	336 5.8 Bl	379 9.9 Eb	310 12.3 Bl
359 8.1 Lg	326 12.4 En	321 9.7 Br	343 5.8 Bl	379 9.8 Kz	317 12.7 Bl
361 8.0 Ch	326 11.7 Ht	322 9.7 Br	346 5.7 Ht	379 9.6 Pi	317 12.2 Sm
362 7.7 Sm	328 12.4 Bl	325 9.7 Br	352 5.9 En	379 10.1 Fd	320 12.5 En
363 8.0 B	332 12.4 En	326 9.7 Br	353 5.5 Bl	380 9.4 Al	321 12.8 Bl
363 7.9 Lh	346 11.4 Ht	329 9.6 Br	353 5.7 Ht	381 9.5 Jo	325 13.2 En
364 7.5 Wm	347 11.8 Bl	343 9.3 Br	355 6.0 Sm	R CAM	328 12.8 Bl
373 7.2 Sp	353 11.4 Ht	344 9.2 Br	358 5.8 Ht	142584	329 12.8 En
375 7.0 Sp	353 11.2 Bl	346 9.2 Br	358 5.8 En	327 9.7 Ch	337 12.7 Bl
375 7.5 Wk	353 11.7 En	350 8.6 B	362 5.5 Sm	354 8.2 Ch	343 13.0 Bl
377 7.0 B	358 11.2 Ht	352 9.1 Br	365 5.9 Ht	357 7.8 Lh	347 14.0 Bl
379 6.6 Eb	358 11.4 Sm	354 9.3 Br	365 5.8 Bl	359 8.4 Wk	353[14.0 Bl

VARIABLE STAR OBSERVATIONS RECEIVED DURING MAY AND JUNE, 1928.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
S APS	RS LIB	T NOR	R CRB	X CRB	Z SCO
145971	*151822*	*153654*	154428	154536	*160021*
355[13.2 Sm	358 7.7 Ht	317[12.2 Sm	362 6.3 Fd	350 9.6 B	353[12.0 En
365[14.0 Bl	361 7.0 En	326 12.8 Ht	363 6.8 Wd	352 9.8 Br	355 12.0 L
RT LIB	362 7.7 Sm	339[11.6 Dr	364 6.1 Pt	352 9.7 Pt	358[12.0 Ht
150018	365 7.7 Ht	346 12.7 Ht	364 6.4 Fd	354 9.7 Br	361[12.0 En
352 8.8 Pt	365 7.8 Bl	353 11.9 Ht	365 6.2 Fd	359 9.5 Br	R HER
379 9.8 Wk	RU LIB	353 11.9 En	366 6.1 Gy	361 9.4 Br	160118
T LIB	*152714*	356 11.9 Dr	366 5.8 Wk	363 9.5 Br	352 13.1 Pt
150519	355 11.6 L	357 11.6 Sm	368 6.1 Pt	368 9.3 Br	357 11.5 Ch
383 13.2 B	378 10.9 Lh	358 11.8 Ht	369 6.8 Wd	370 9.4 Br	379 9.4 Fd
Y LIB	378 11.0 B	360 11.4 En	369 6.0 Sp	376 9.1 B	380 9.7 Jo
150605	391 9.4 B	365 10.8 Ht	369 6.1 Pt	R SER	381 9.5 Pi
346 13.0 L	R NOR	Z LIB	369 5.9 Fd	154615	381 9.1 Jo
362 12.1 An	*152849*	*154020*	370 6.1 Pt	329 8.1 Ch	U SER
388 13.6 B	310 9.2 Bl	328 12.0 Bl	370 5.8 Fd	345 8.8 Wk	160210
S LIB	317 9.2 Bl	337 12.5 Bl	371 6.6 Wd	351 8.9 Ch	352 12.3 Pt
151520	328 9.0 Bl	348 12.5 Bl	372 6.1 Pt	352 8.9 Pt	359 12.1 Wk
327 8.5 Ch	328 9.9 En	R CRB	373 6.1 Pt	354 8.6 Wk	360 12.2 Fd
349 9.5 L	337 8.8 Bl	154428	373 5.8 Wd	357 9.1 B	364 12.0 Fd
351 8.9 Ch	339 8.8 Dr	267 5.6 Fu	373 6.0 Gb	357 9.1 Lh	365 12.0 B
352 9.4 Pt	347 8.6 Bl	298 5.5 Fu	374 6.0 Pt	360 8.5 Wk	372 11.0 Fd
362 9.9 An	353 8.8 En	325 5.7 Fu	374 6.0 Wk	365 9.5 B	374 11.6 Fd
S SER	354 8.6 Bl	327 6.2 Ch	374 5.8 Fd	375 9.1 Wk	376 11.3 Fd
151714	356 8.5 Dr	330 6.0 Ch	375 5.9 Fd	381 10.3 Pi	378 10.7 Wk
348 13.4 L	357 8.4 Sm	333 6.0 Ch	375 6.1 Pt	386 10.6 B	379 11.1 Fd
388 13.3 L	360 8.5 En	339 6.0 Ch	375 5.9 Sp	389 11.0 Wk	379 10.9 Jn
394 12.5 L	365 7.6 Bl	343 6.0 Sw	376 6.0 Pt	V CRB	381 10.8 Pi
S CRB	366 7.6 Dr	346 6.0 L	377 6.0 Wd	154639	386 10.0 B
151731	X LIB	346 6.0 An	378 6.0 Wd	352 11.1 Pt	391 9.6 Wk
327 10.6 Ch	*153020*	347 5.8 Sw	378 6.1 Pt	354 10.5 B	X SCO
344 10.6 Wk	328 11.1 Bl	347 6.1 Ch	379 6.0 Jn	374 10.8 B	*160221a*
346 11.3 Ch	337 10.9 Bl	348 6.0 L	379 6.0 Jo	374 10.7 Lh	329 11.3 Bl
352 11.4 Pt	348 10.5 Bl	349 6.0 L	379 5.8 Sw	379 11.3 Pi	337 11.5 Bl
354 11.6 Wk	354 10.7 Bl	352 6.1 Pt	379 6.0 Fd	393 10.4 B	348 12.0 Bl
357 11.4 Lh	365 11.8 Bl	353 6.1 Pt	379 6.1 Wk	RR LIB	354 12.3 Bl
357 11.4 B	W LIB	354 6.2 Pt	380 6.4 Wd	*155018*	SX HER
357 11.6 Fd	*153215*	355 6.2 Pt	380 5.8 Jo	355[14.0 L	160325
360 11.7 Fd	328 11.6 Bl	355 6.0 Gt	381 5.8 Jo	Z CRB	307 8.6 Br
365 11.3 Fd	337 11.9 Bl	355 6.0 An	381 6.2 Wd	155229	319 8.6 Br
369 11.8 Wk	348 12.8 Bl	355 6.0 L	381 6.0 Pi	365[13.0 B	320 8.6 Br
374 12.0 Fd	355[13.1 L	356 6.1 Lh	383 5.5 Wk	383[13.7 B	322 8.6 Br
374 11.9 Lh	388[13.5 B	357 6.1 Sp	389 5.3 Wk	RZ Sco	325 8.6 Br
374 11.8 B	S UMI	357 6.1 Gy	389 6.0 Ah	*155823*	326 8.6 Br
375[12.0 Fd	153378	357 6.0 Jo	393 6.1 Ah	326 9.7 Ht	329 8.6 Br
381 12.3 Pi	334 10.2 Ch	357 6.0 B	395 6.2 Ah	351 8.9 En	343 9.0 Br
384 11.5 Wk	357 10.1 Lh	357 6.1 Ch	397 6.2 Ah	352 9.3 Pt	344 9.1 Br
RS LIB	357 9.8 B	357 6.5 Fd	407 5.9 Pc	353 9.1 Ht	346 9.2 Br
151822	370 10.0 B	358 5.9 An	408 6.0 Jo	355 8.6 Sm	346 8.5 L
317 9.9 Bl	374 11.2 Pt	358 6.1 Gt	409 6.5 Gy	358 9.1 Ht	352 8.2 Pt
326 9.7 Ht	379 11.5 Eb	358 6.0 L	X CRB	358 9.3 En	352 9.1 Br
328 9.0 Bl	379 11.5 Kz	359 5.4 Wk	154536	365 9.0 Ht	353 8.3 Pt
337 8.7 Bl	379 11.0 B	359 6.1 An	320[10.5 Br	X HER	354 8.5 Pt
346 8.1 Ht	392 11.4 B	359 6.1 L	321[10.5 Br	155947	354 8.8 Br
348 8.0 Bl	U LIB	360 6.1 Pt	325[10.3 Br	323 6.7 Fu	355 8.4 Pt
349 7.7 L	*153620a*	360 6.4 Fd	326[10.2 Br	Z SCO	359 8.5 Br
353 8.0 Ht	328 10.3 Bl	360 6.1 Ch	329 10.1 Br	*160021*	361 8.3 Br
353 7.5 En	337 10.7 Bl	361 6.1 Pt	343 9.9 Br	326 11.8 Ht	361 8.0 Pt
354 8.0 Bl	348 11.5 Bl	362 6.1 Pt	344 9.9 Br	328 12.2 Bl	362 8.0 Pt
355 7.6 Sm	354 12.1 Bl	362 6.0 L	346 9.8 Br	348 12.5 Bl	364 8.0 Pt

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
SX HER	W CRB	W HER	RR OPH	RT HER	RS OPH
160325	161138	163137	*164319*	170627	174406
368 7.9 Pt	359 9.1 Br	319 13.0 Br	309 10.4 Bf	349 13.0 Wk	354 11.2 Pt
369 7.8 Pt	360 9.1 Br	346 12.2 Br	316 9.6 Bf	374 10.5 B	U ARA
370 7.9 Pt	360 9.3 Wk	354 11.7 Ch	325 9.7 Bf	381 10.0 Pi	*174551*
370 8.0 Br	363 9.0 Br	352 11.7 Br	337 9.4 Bf	384 10.2 Wk	355[12.3 Sm
372 8.0 Pt	370 9.2 Br	354 11.5 Br	348 9.7 Bf	RW SCO	357[12.3 En
373 8.0 Pt	374 9.5 Sp	354 11.7 Pt	354 9.8 Pt	*170833*	RY HER
374 7.9 Pt	378 9.7 B	357 11.2 Ch	355 9.8 Sm	337[13.0 Bl	175519
375 8.0 Pt	378 9.8 Lh	357 11.3 Sp	362 9.7 L	354[13.0 Bl	333 11.8 Ch
376 8.0 Pt	379 9.9 Wk	357 10.6 Jo	363 9.5 En	Z OPH	354 13.3 Pt
378 8.4 Pt	391 10.8 Wk	359 11.4 Br	391 10.8 B	171401	391 13.3 B
W SCO	W OPH	360 11.5 Br	S HER	354 12.6 Pt	V DRA
160519	*161607*	361 11.5 Br	164715	361 12.0 Lg	175654
337[13.0 Bl	362 13.7 L	363 11.3 Br	345 10.3 Wk	RS HER	354 13.8 Pt
348[12.5 Bl	388 12.7 B	365 11.0 B	354 10.6 Wk	171723	R PAV
RU HER	V OPH	370 11.1 Br	354 10.5 Pt	354 8.5 Pt	*180363*
160625a	*162112*	374 10.5 Sp	354 11.3 Ch	379 7.8 B	326[12.3 Ht
345 12.0 Wk	354 7.8 Pt	379 10.3 Pi	365 11.2 B	380 9.5 Jo	339[11.3 Dr
346 12.8 L	391 7.8 B	379 9.8 Jo	381 12.1 Pi	381 9.3 Jo	353[12.3 Ht
352 12.3 Pt	U HER	381 9.7 Jo	378 10.9 Wk	386 7.6 B	357[11.9 En
358 12.5 Wk	162119	386 9.8 B	386 12.0 B	391 7.6 B	358[12.3 Ht
377 12.5 Lh	344 11.5 Wk	R UMI	RS SCO	S OCT	T HER
377 12.6 B	354 13.3 Wk	163172	*164844*	*172486*	180531
381[12.1 Pi	354 12.2 Pt	365 10.2 B	317 11.1 Bl	321[13.0 Bl	333 8.3 Ch
384 12.2 Wk	360 11.9 Ch	R DRA	326 11.8 Ht	326[13.0 Ht	345 7.7 Wk
R SCO	381 12.2 Pi	163266	337 11.4 Bl	347 13.5 Bl	354 7.7 Wk
161122a	383 11.4 B	327 7.8 Ch	348 11.9 Bl	350[12.8 En	354 7.6 Pt
309[14.2 Bf	384 11.9 Wk	344 7.9 Wk	354 12.3 Bl	358[13.0 Ht	357 7.9 Jo
325[14.3 Bf	Y SCO	354 7.9 Wk	358[12.0 Ht	361[12.8 En	358 7.7 L
337[14.3 Bf	*162319*	354 7.8 Pt	361[12.0 En	RU OPH	360 8.3 Fd
348[14.2 Bf	362 13.5 L	356 7.9 Ch	RR SCO	172809	364 8.0 Fd
353[12.6 Ht	g HER	357 8.2 Gy	*165030*	354 13.0 Pt	365 8.0 Fd
355[12.6 Sm	162542	357 7.6 Jo	326 5.4 Ht	388[13.0 B	369 8.3 Fd
358[12.6 Ht	325 5.0 Fu	360 7.8 Wk	337 5.5 Bl	RT SER	372 8.4 Fd
361[12.6 En	SS HER	360 7.9 Fd	348 5.6 Bl	*173212*	373 8.6 Fd
S SCO	162807	365 7.7 Fd	353 6.1 Ht	362 12.1 L	374 8.7 Fd
161122b	354 9.0 Pt	366 8.0 Ah	353 6.2 En	RU SCO	375 9.0 Fd
309 13.6 Bf	355 8.6 L	367 8.0 B	355 6.4 Sm	*173543*	375 9.1 Wk
325[14.3 Bf	363 8.7 Sw	369 7.9 Fd	354 6.2 Bl	337 13.3 Bl	376 9.1 Fd
337[14.3 Bf	378 9.7 B	370 7.9 Fd	358 6.4 Ht	354 12.9 Bl	378 9.1 Fd
348[14.2 Bf	378 10.9 Wk	371 8.3 Wd	361 6.4 En	SV SCO	379 9.2 Fd
353[12.6 En	380 9.7 Sw	372 7.8 Fd	365 6.7 Bl	*174135*	375 9.2 Gb
358[12.6 Ht	T OPH	373 7.9 Fd	365 7.0 Ht	337[11.4 Bl	379 9.4 Jo
361[12.6 En	*162815*	374 7.8 Fd	SS OPH	354[12.5 Bl	381 9.5 Jo
W CRB	328 11.1 Bl	375 8.0 Fd	165202	W PAV	382 9.2 Fd
161138	337 10.6 Bl	375 8.3 Wk	354 13.0 Pt	*174162*	389 10.8 Wk
319 11.4 Br	348 10.6 Bl	378 7.9 Fd	RV HER	321[12.3 Bl	408 11.0 Jo
320 11.4 Br	354 11.0 Pt	379 8.0 Fd	165631	326 12.7 Ht	W DRA
325 11.0 Br	354 10.6 Bl	379 8.5 B	354 14.6 Pt	337 10.0 Bl	180565
326 10.9 Br	358 11.3 L	380 8.3 Jo	357[13.7 B	347 9.5 Bl	354 10.2 Pt
329 10.6 Br	358 11.3 Gt	381 8.5 Jo	RT SCO	353 8.7 Ht	393 12.3 B
343 9.2 Br	358 11.0 An	382 7.9 Fd	*165636*	354 8.8 Bl	X DRA
344 9.2 Br	365 10.8 Bl	389 9.6 Wk	337 10.3 Bl	357 8.6 En	180666
344 9.7 Wk	391 11.9 B	389 9.2 Ah	348 8.9 Bl	358 8.4 Sm	354 10.5 Pt
346 9.2 Br	S OPH	393 9.0 B	354 8.6 Bl	358 8.6 Ht	393 11.4 B
352 9.0 Br	*162816*	393 9.1 Ah	365 8.7 Bl	365 8.5 Ht	NOV OPH
354 8.9 Br	337[13.3 Bl	395 9.4 Ah	R OPH	365 8.3 Bl	180911
354 9.0 Pt	362[13.8 L	397 9.5 Ah	*170215*		354[12.0 Pt
354 9.3 Wk	354[13.3 Bl	408 9.7 Jo	383 13.1 B		

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J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

RY OPH
181103
354 7.8 Pt
W LYR
181136
354 9.0 Sw
354 8.6 Wk
354 9.0 Pt
374 8.5 Gb
378 8.3 Wk
379 8.0 Jo
380 8.2 Sw
381 8.3 Jo
391 9.0 Wk
408 8.1 Jo
RU DRA
181859
307 10.2 Br
319 10.8 Br
320 10.9 Br
322 11.0 Br
325 11.1 Br
326 11.1 Br
329 11.1 Br
343 11.6 Br
344 11.7 Br
346 11.7 Br
354 12.4 Br
RV SGR
182133
337 14.2 Bl
356 14.6 Bl
SV HER
182224
354 10.5 Pt
358 10.9 L
X OPH
183308
354 8.7 Pt
362 8.7 L
381 8.4 Jo
408 8.0 Jo
RS DRA
184074
307 11.0 Br
319 10.6 Br
320 10.5 Br
322 10.4 Br
325 10.2 Br
326 10.2 Br
329 10.1 Br
343 9.3 Br
354 9.2 Br
359 9.1 Br
361 9.0 Br
363 8.9 Br
370 8.9 Br
R SCT
184205
328 5.7 Ch

R SCT
184205
334 5.7 Ch
346 5.1 L
359 5.8 Lg
360 6.0 Pt
361 6.0 Pt
361 5.7 Lg
362 6.0 Pt
362 5.5 L
364 6.0 Pt
364 5.1 Fd
369 5.9 Lg
369 5.5 Pt
370 5.6 Pt
372 5.6 Fd
373 6.0 Pt
378 5.7 Fd
378 6.5 Gb
380 5.6 Sw
381 5.3 Jo
390 5.7 Gy
407 5.1 Pc
408 5.0 Jo
409 5.1 Gy
NOV AQL
184300
333 10.7 Ch
361 11.5 Pt
364 11.6 Pt
RX LYR
185032
331[11.9 Ch
R LYR
185243
348 4.5 Go
S CRA
185437a
337 11.5 Bl
356 11.5 Bl
365 11.9 Bl
ST SGR
185512a
333[11.2 Ch
350[12.7 L
R CRA
185537a
337 12.3 Bl
356 12.5 Bl
T CRA
185537b
337 13.3 Bl
356[13.0 Bl
Z LYR
185634
361 10.8 Pt
RT LYR
185737
330[11.1 Ch

R AQL
190108
328 9.3 Ch
361 7.2 Pt
383 7.4 Ah
389 7.0 Ah
393 7.2 Ah
395 7.0 Ah
397 6.8 Ah
V LYR
190529a
361 13.5 Pt
RX SGR
190818
338[11.1 Ch
RW SGR
190819a
338 9.7 Ch
361 9.5 Pt
TY AQL
190907
361 10.5 Pt
S LYR
190925
333[12.6 Ch
X LYR
190926
361 9.0 Pt
RS LYR
190933a
330[11.1 Ch
U DRA
190967
328 10.0 Ch
358 11.5 Ch
361 11.7 Pt
W AQL
191007
335 8.8 Ch
361 8.0 Pt
T SGR
191017
338[11.0 Ch
361 12.5 Pt
R SGR
191019
338 9.9 Ch
358 8.4 Ch
361 8.4 Pt
RY SGR
191033
330 6.5 Ch
337 6.0 Bl
339 6.4 Dr
346 6.2 L
353 6.9 Ht
355 6.7 L
356 7.0 Dr
356 6.5 Bl
358 6.9 Ht

RY SGR
191033
358 6.5 Ch
361 6.3 Pt
362 6.3 L
364 6.3 Pt
365 6.5 Bl
366 6.6 Dr
TV SGR
191124
337 13.2 Bl
356 12.2 Bl
365 12.1 Bl
S SGR
191319a
302 11.5 Bl
337[13.0 Bl
356[13.4 Bl
361 13.6 Pt
— SGR
191319b
361 12.7 Pt
SW SGR
191331
337 10.6 Bl
356 11.7 Bl
365 11.7 Bl
TZ CYG
191350
361 10.3 Pt
375 11.0 Sp
U LYR
191637
361 9.7 Pt
CH CYG
192150
241 7.1 Fu
257 7.3 Fu
260 7.4 Fu
AF CYG
192745
241 7.6 Fu
256 7.4 Fu
257 7.4 Fu
260 7.3 Fu
TY CYG
192928
331[11.2 Ch
RT AQL
193311
331 11.4 Ch
R CYG
193449
328 6.5 Ch
334 7.1 Ch
357 8.6 Wk
357 8.2 Fd
360 8.4 Fd
361 7.2 Pt
364 8.6 Fd

R CYG
193449
365 7.9 Fd
369 8.1 Fd
370 8.0 Fd
372 8.0 Fd
373 8.2 Fd
374 8.1 Fd
376 8.3 Fd
378 9.0 Wk
378 8.3 Fd
379 8.2 Fd
379 8.0 Jo
379 8.5 Sw
381 7.8 Jo
408 8.7 Jo
RV AQL
193509
361 8.6 Pt
T PAV
193972
309 10.4 Bl
317 10.8 Bl
326 11.9 Bl
337 11.9 Bl
347 13.5 Bl
353 13.2 Ht
356 13.3 Dr
357[11.9 En
358[13.2 Ht
RT CYG
194048
328 10.2 Ch
331 9.9 Ch
334 9.8 Ch
358 8.4 Ch
361 8.3 Pt
373 8.1 Fd
374 8.0 Fd
378 8.0 Fd
378 8.2 Wk
379 8.1 Jo
379 8.1 Fd
381 7.7 Jo
408 7.5 Jo
TU CYG
194348
328[11.2 Ch
X CYG
194632
336 6.8 Ch
343 6.2 Ch
358 4.9 Ch
361 5.0 Sp
361 4.8 Pt
370 4.8 Sp
374 5.0 Sp
408 5.6 Jo

RR SGR
194929
337 11.1 Bl
356 10.7 Bl
365 9.6 Bl
RU SGR
195142
337 6.9 Bl
353 7.0 Ht
356 7.1 Bl
358 7.0 Ht
365 7.1 Bl
NOV CYG
195553
352[12.2 Pt
378[12.2 Pt
Z CYG
195849
328 8.6 Ch
361 9.7 Pt
S TEL
195855
337 13.0 Bl
356 12.8 Bl
SY AQL
200212
350 12.4 L
361 12.0 Pt
S CYG
200357
328[11.4 Ch
361 11.2 Pt
380 9.0 Jo
381 9.5 Jo
R CAP
200514
361 12.1 Pt
S AQL
200715a
358 10.5 Ch
361 9.9 Pt
387 9.5 Wk
RW AQL
200715b
361 9.3 Pt
387 9.3 Wk
R TEL
200747
337[13.5 Bl
356[13.5 Bl
W CAP
200822
337 11.7 Bl
356 11.6 Bl
361 11.5 Pt
Z AQL
200906
309 13.6 Bf
316 13.8 Bf
325 13.6 Bf

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
Z AQL	WX CYG	T DEL	T CAP	S MIC	RS PEG
200906	201437b	204016	210868	*212030*	220714
337 12.1 Bf	408 10.6 Jo	339 10.4 Ch	246 9.0 Fu	356 13.4 Bl	364 10.0 Pt
348 11.0 Bf	U CYG	364 9.0 Pt	257 9.4 Fu	Y CAP	S LAC
361 10.4 Pt	201647	V AQR	267 9.8 Fu	*212814*	222439
RS CYG	361 8.6 Pt	204102	294 9.8 Fu	356 12.6 Bl	364 8.5 Pt
200938	364 8.6 Fd	364 8.3 Pt	325 10.3 Fu	W CYG	R IND
328 8.9 Ch	365 9.1 Fd	W AQR	328 10.3 Ch	213244	*222867*
330 9.0 Ch	372 8.9 Fd	*204104*	342 9.9 Wk	239 6.4 Fu	309 12.3 Bl
331 9.0 Ch	374 8.4 Sp	348 11.9 Bf	345 9.7 Gy	260 6.4 Fu	316 11.5 Bl
333 9.0 Ch	378 8.7 Fd	U CAP	349 9.9 Wk	269 6.4 Fu	336 9.6 Bl
334 9.0 Ch	379 8.2 Jo	*204215*	354 9.9 Sw	283 6.4 Fu	343 9.1 Bl
335 9.0 Ch	379 8.7 Fd	337 11.1 Bl	354 9.5 Wk	349 6.5 L	353 9.0 Bl
336 9.0 Ch	381 8.0 Jo	356 11.4 Bl	357 9.8 Gy	362 6.6 L	364 8.8 Bl
338 9.0 Ch	408 7.9 Jo	T AQR	358 9.7 Ch	S CEP	R LAC
339 9.1 Ch	U MIC	*204405*	360 9.4 Fd	213678	223941
343 8.9 Ch	*202240*	336 10.8 Ch	364 9.3 Fd	364 8.6 Pt	364 10.5 Pt
350 8.1 L	337[13.6 Bl	353 9.4 Ch	364 9.2 Pt	379 8.5 Jo	R PEG
351 8.9 Ch	356 13.6 Bl	364 9.4 Pt	365 9.2 Fd	380 8.6 Jo	230110
353 8.8 Ch	RU CAP	RZ CYG	372 9.1 Fd	381 8.4 Jo	364 10.8 Pt
357 7.6 Jo	*202622*	204846	373 9.2 Fd	408 8.7 Jo	V CAS
358 8.8 Ch	325 10.0 Bf	364 9.4 Pt	374 9.1 Fd	RU CYG	230759
361 8.0 Pt	337 9.8 Bf	S IND	374 9.5 Wk	213753	364 8.0 Pt
379 7.8 Jo	348 10.2 Bf	*204954*	375 9.2 Fd	328 8.7 Ch	380 8.7 Sw
380 7.0 Jo	Z DEL	337 14.0 Bl	375 9.4 Gb	358 8.6 Wk	383 8.3 Ah
381 7.5 Jo	202817	356 13.4 Bl	378 9.1 Fd	364 8.4 Pt	397 9.2 Ah
408 7.3 Jo	361 11.6 Pt	R VUL	379 9.0 Fd	379 8.7 Wk	Z AND
R DEL	ST CYG	205923a	379 9.5 Sw	RV CYG	232848
201008	202954	339 10.3 Ch	380 8.5 Jo	213937	364 9.5 Pt
350 12.4 L	361 12.6 Pt	364 7.9 Pt	381 8.5 Jo	364 6.2 Pt	ST AND
361 12.8 Pt	V VUL	381 8.0 Jo	389 9.1 Ah	U CAP	233335
RT CAP	203226	V CAP	389 9.4 Wk	214058	364 8.7 Pt
201121	361 8.6 Pt	*210124*	393 9.0 Ah	358 4.0 Wk	386 8.7 Wk
361 6.3 Pt	R MIC	337[12.7 Bl	395 8.9 Ah	376 4.0 Wk	R AQR
SX CYG	*203429*	356[13.0 Bl	397 8.7 Ah	R GRU	*233815*
201130	337 12.4 Bl	X CAP	408 8.6 Io	*214247*	356 7.3 Bl
361 13.6 Pt	356 13.5 Bl	*210221*	409 8.7 Gy	356 8.0 Bl	RR CAS
RT SGR	S DEL	337[12.7 Bl	RR AQR	365 7.7 Bl	235053
201139	203816	356 13.2 Bl	*210903*	VV CEP	355[11.7 Bn
356 10.8 Bl	361 9.2 Pt	X CEP	364 11.4 Pt	215363	385[11.7 Bn
365 11.5 Bl	V CYG	210382	X PEG	239 5.3 Fu	V CET
337 10.1 Bl	203847	353[13.7 GC	*211614*	241 5.3 Fu	*235209*
WX CYG	333[11.8 Ch	381[13.7 GC	364 9.2 Pt	246 5.3 Fu	356[12.8 Bl
201437b	364 9.0 Pt	RS AQR	T CAP	255 5.5 Fu	R TUC
328 10.8 Ch	Y AQR	*210504*	*211615*	256 5.5 Fu	*235265*
350 9.8 L	*203905*	364 13.0 Pt	337[12.7 Bl	266 5.2 Fu	317 12.9 Sm
361 10.0 Pt	325[13.5 Bf	R EQU	356[13.0 Bl	283 5.3 Fu	325 12.9 En
379 9.7 Jo	337[13.5 Bf	210812	S MIC	RZ PEG	R CAS
380 9.8 Jo	348 14.8 Bf	364 14.3 Pt	*212030*	220133b	235350
			337 13.4 Bl	364 12.0 Pt	395 11.1 Ah

RAPIDLY VARYING IRREGULAR VARIABLES.

005840 RX ANDROMEDAE—

5361.9 12.4 Pt 5364.9[12.4 Pt

060547 SS AURIGAE—

5307.1 13.0 Bg 5327.2[11.6 Ch

5316.1[14.5 Bg 5330.1 15.4 Bg

5321.1 15.2 Bg 5330.2[11.6 Ch

5325.1 15.2 Bg 5332.1[13.9 Bg

060547 SS AURIGAE—

5333.1[11.0 Ch 5348.4[13.9 L

5341.1[13.9 Bg 5348.8[14.1 Lg

5345.2[11.0 Ch 5349.4[13.9 L

5346.3[13.9 L 5349.8[14.1 Lg

5347.1[15.2 Bf 5350.6[13.6 B

5347.8[14.1 Lg 5352.1 15.2 Bg

060547 SS Aurigae—

5353.8[14.1 Lg
5354.1 15.4 Bg
5355.4[13.9 L
5356.8[14.1 Lg
5357.6[11.6 Sp
5358.4[13.9 L
5359.8[14.1 Lg
5360.1 14.8 Bf
5361.8[14.1 Lg
5363.6[12.8 Cl
5368.8[14.1 Lg
5371.8[14.1 Lg
5372.8[14.1 Lg
5373.8[14.1 Lg
5374.7[12.6 Pt
5375.6 12.4 Pt
5376.8[14.1 Lg
5378.7[12.6 Pt
5368.7[12.4 Pt

074922 U Geminorum—

5321.1 14.1 Bg
5325.1 13.7 Bg
5327.2[12.4 Ch
5330.1 14.6 Bg
5332.1 14.5 Bg
5341.1[13.3 Bg
5344.6[13.E Lh
5346.1[12.3 Ch
5347.1 14.2 Bf
5347.8 14.0 Lg
5348.8 14.0 Lg
5349.6 14.0 B
5349.6 13.9 Lh
5349.8 14.0 Lg
5352.1 14.3 Bg
5352.6 13.9 GC
5353.6 14.0 GC
5353.8 14.0 Lg
5354.1 14.6 Bg
5355.6[13.8 GC
5356.8 14.0 Lg
5357.6[13.7 GC
5358.1[13.3 Ch
5359.8 14.0 Lg
5360.1 14.4 Bf
5360.8 14.0 Lg
5361.8 14.0 Lg
5363.6[12.5 Cl
5366.6[12.4 GC
5368.6 10.6 B
5368.7 9.8 Pt
5368.8 9.4 Lg
5369.6 9.7 GC
5370.6 9.9 B
5371.6 10.1 B
5371.6 10.2 GC
5371.8 9.8 Lg
5372.7[10.0 Pt
5372.8 10.0 Lg
5374.6 12.7 B
5374.6 12.2 GC
5374.6 12.7 Cl
5374.6 12.8 Lh
5375.7[12.4 Pt

074922 U Geminorum—

5376.6 13.7 GC
5376.8 13.5 Lg
5378.7[12.4 Pt
5379.6[13.8 GC
5377.6[13.8 B

132002 W Virginis—

5357.6 9.8 Sp
5359.9 10.1 Lg
5364.9 9.3 Wk
5374.7 10.0 Sp
5377.6 10.0 Lh
5377.6 10.0 B
5379.9 9.6 Wk
5391.8 10.0 Wk

202946 SZ Cygni—

5352.7 9.5 Pt
5354.7 9.5 Pt
5356.8 9.1 Pt
5361.9 9.5 Pt
5362.8 9.4 Pt
5364.8 9.6 Pt
5369.8 9.4 Pt
5370.8 8.9 Pt
5372.7 9.0 Pt
5373.8 9.0 Pt
5374.7 9.0 Pt
5376.7 9.2 Pt
5378.7 9.5 Pt

213843 SS Cygni—

5328.5 8.3 Ch
5333.4 10.5 Ch
5336.4 11.5 Ch
5346.6 11.9 L
5349.6 11.5 L
5353.4 11.9 Ch
5354.7 11.7 Pt
5355.6 11.7 L
5356.8 11.7 Pt
5358.9 11.7 Wk
5359.4 11.7 Ch
5361.2 9.0 Lg
5361.9 8.9 Pt
5362.6 8.5 L
5362.8 9.0 Pt
5364.9 9.1 Pt
5366.1 8.4 Wk
5369.2 8.3 Lg
5369.8 8.9 Pt
5370.8 9.0 Pt
5373.8 9.4 Pt
5378.0 11.9 Wk
5379.0 11.8 Wk
5384.9 12.0 Wk
5386.9 11.9 Wk
5387.9 11.8 Wk
5389.9 11.8 Wk
5393.4[11.0 Ah
5395.5 11.6 Ah
5397.5[10.9 Ah
5407.7 11.7 Pc

Bi-Monthly Summary.

Observer	Initial	Vars.	Observations
Ahnert	Ah	10	46
Allen	Al	15	15
Ancarani	An	18	25
Baldwin	Bl	99	413
Bappu	Bf	21	59
Barry	By	6	11
Beyer	Br	16	167
Bhaskaran	Bg	15	72
Bouton	B	88	147
Brown	Bn	3	7
Chandra	Ch	97	178
Clement	Cl	6	8
Dartayet	Dr	27	62
Dawson	Dw	13	14
Ebert	Eb	20	20
Ensor	En	54	142
Ford	Fd	19	121
Furahata	Fu	22	79
Gaebler	Gb	6	6
Gallanti	Gt	4	5
Gomi	Go	6	20
Gregory	Gy	7	13
Houghton	Ht	35	161
Johnstone	Jn	6	6
Jones	Jo	31	92
Lacchini	L	48	75
Lee	Lh	37	42
Logan	Lg	34	86
Kohl	Kl	4	11
Kurtz	Kz	20	20
Peltier	Pt	174	261
Pickering	Pi	30	30
Proctor	Pc	5	5
Smith, W.H.	Sm	48	82
Spears	Sp	16	26
Swanson	Sw	13	22
Watkins	Wk	58	202
Webb	Wd	9	27
Whitney	Wy	5	5
Williams, R.	Wm	2	2
Georgetown	GC	14	39
Coll. Obs.	—	—	—
Totals	41	384	2824

June 30, 1928.

Leon Campbell, Recording Secretary.

COMET NOTES.

By G. VAN BIESBROECK.

At the time of writing but one faint comet is under observation, namely Comet Stearns, which has been seen now for a year and a half. It follows closely Y. C. Chang's ephemeris given in the May number. It is not quite as faint as predicted there, yet a large instrument is required to see the object, which stays at a high northern declination in Draco.

J. Polak gives in *Astronomische Nachrichten*, No. 5540, an ephemeris for the present return of periodic comet Holmes, which is reproduced here in an abbreviated form:

1928 0^h U.T.	(1928) h m s	° ′	Log. r	Log. Δ
Aug. 2	3 8 28	+35 12.1	0.399	0.406
10	19 0	36 51.5		
18	28 37	38 27.9	0.406	0.381
26	37 9	40 1.2		
Sept. 3	44 22	41 31.2	0.413	0.355
11	49 59	42 58.0		
19	53 48	44 20.8	0.420	0.329
27	55 28	45 38.6		
Oct. 5	3 55 0	+46 48.4	0.428	0.306

It is seen that the object is expected in the morning sky. It moves slowly in the constellation of Perseus. Although the time of perihelion is already past the conditions of visibility are improving and it is hoped that the search will be successful in spite of the large distance which will make the comet quite faint.

At the Leiden meeting of the International Astronomical Union various questions were discussed which have a bearing on comets. It was agreed that in the telegraphic code in use for cometary announcements a provision would be made for a concise description of the objects: this information will be useful for the observers, who will know better what kind of object to look for, as well as for the computers, who thereby will be able to judge how reliable the positions can be expected to be. The details of the new arrangement were left to be worked out by the distributing centers.

In order to facilitate comparisons and to insure uniformity, a resolution was passed concerning the dates for which ephemerides are to be computed. The midnight following an integral Julian date, which is divisible by 40 will be used in giving osculation epochs for the elements and for ephemerides those that are divisible by 8 (or 4, etc.).

The steps taken for introducing the equinox of 1950.0 in the almanacs will simplify the work when long computations, covering an interval of several years have to be made, as is the case in perturbation work. For the ordinary computations on comets and especially in the case of the newly found ones, the coördinates will be referred to the beginning of the current year as was customary.

Leiden, Holland, July 13, 1928.

Note on Comet 1928*a* (Reinmuth).

Since there is little likelihood that further observations of Reinmuth's Comet can be obtained, for it is now fainter than 17^M and well over in the western sky

at sunset, it appears instructive to compare the results of the three orbits now extant with the last two observations made at the Lick Observatory by Crawford on June 14 and 15 (Crossley reflector). The residuals are:

1928 U.T.	α(1928.0)	δ(1928.0)		Δα	Δδ
June 14.22917	$11^h\ 10^m\ 25^s.99$	+13° 35′ 9″.2	Crommelin	−113″	+ 61″.1
			Ber. and Whip.	— 6	+ 6 [2]
			Seagrave	+280	−149 [3]
June 15.22951	11 12 4.20	+13 23 49.9	Crommelin	−112″	+ 59″
			Ber. and Whip.	— 5	+ 3
			Seagrave	+284	−145

A comparison of the three sets of elements can be found in *Obs.*, Vol. LI, p. 167, May, 1928. It will be noticed that the orbits are based on practically the same intervals. Thus, Crommelin's, Berman's and Whipple's, and supposedly Seagrave's first two positions, which are based on observations by Reinmuth, are identical while Crommelin's third place is furnished by Struve, Berman's and Whipple's third by Crawford, and Seagrave's third by Van Biesbroeck. Seagrave states that his orbit is based solely on observations made by Van Biesbroeck but Van Biesbroeck appears to have first observed the comet on Feb. 25. (*A.J.*, Vol. 38, No. 905, p. 164, 1928.)

Identity of this comet with Taylor's Comet (1916 I) suggested itself by comparison of the rough elements originally published in H.C.O. Announcement Card No. 60. By the application of Tisserand's criterion to our last elements the identity was rendered doubtful (*Lick Observatory Bulletin* 399). Since then Y. C. Chang (*A.J.*, Vol. 38, No. 904, p. 156, 1928), has computed the perturbations for both comets, from our last elements (*L.O. Bulletin* 399) of the Reinmuth Comet and from Jeffers' elements of Taylor's Comet (*L.O. Bulletin* 120, 1922), well covering the period of close approach of Taylor's Comet to Jupiter in 1925, and has reached the conclusion that the two comets are not identical. The perturbations of the Taylor Comet were computed by Chang from 1923 April to 1927 December, and should materially assist in the rediscovery of the comet, since the ephemeris by F. R. Cripps in the B.A.A. Handbook for 1928 takes no account of the perturbations. Attention should be called, however, to the fact that Jeffers found his final elements to be quite uncertain.

Louis Berman.

Lick Observatory, Mount Hamilton, California, June 25, 1928.

GENERAL NOTES.

Dr. Edgar Fahs Smith, professor of chemistry at the University of Pennsylvania from 1888 to 1920 and provost from 1911 to 1920, died after a brief illness on May 3, in his seventy-second year. (*American Journal of Science*, June, 1928.)

L. F. Fouts.— The *Dallas News* carried several columns in its feature section June 3 concerning the life and death of L. F. Fouts, retired railroad telegrapher, who died March 28 at the age of 78. Mr. Fouts was from its beginning an organizer and a member of the Dallas Astronomical Society, and at one time occupied its president's chair for the term of one year.

Senor Joaquin Gallo was awarded an honorary degree of Doctor of Science at Northwestern University at its recent commencement exercises on the 18th of June, with the characterization:

"Professor of Mathematics and Astronomy in the University of Mexico and Director of the Observatorio Astronomico Nacional de Tacubaya. An eminent investigator, an able administrator, an example of steadfastness to his Country through turbulent times. Even as science knows no nationality and his science no boundaries, the mutual esteem of our peoples ignores the Rio Grande."

Mr. G. B. Lacchini, an outstanding amateur astronomer of Faenza, Italy, and for many years an active and valuable member of the American Association of Variable Star Observers has recently been honored with an appointment as Assistant Astronomer to the Royal Observatories of Italy. The commission designated to investigate his eligibility for this post was composed of Bianchi, President, Carnera, and Abetti, Secretary. It reviewed the meritorious achievements of Signor Lacchini in observational astronomy and expressed to him its cordial congratulations. It has not as yet been determined to what observatory Signor Lacchini will be assigned. His many friends and co-workers in America are hoping that he may be allowed to retain his present private observatory at Faenza, where, perhaps operating under the administration of the Royal Observatory of Capodimonte, he might continue, as in the past, to contribute to the American Association his valuable observations of variable stars.

An Unusually Brilliant Meteor.— The following account of a large meteor is taken from a newspaper clipping sent us by Mr. George A. Knapp, Maryville, Tennessee.

"Preceded by a small tornado, hail and rainstorms in south Georgia, a fiery meteor described as larger than a house flashed through the skies from Waycross, Georgia, to Charleston, South Carolina, about midnight last night, to end in an explosion that shook buildings and awakened hundreds of people in towns along the route.

"The celestial phenomenon was visible over an area approximately 400 miles square, 200 miles on either side of the flash.

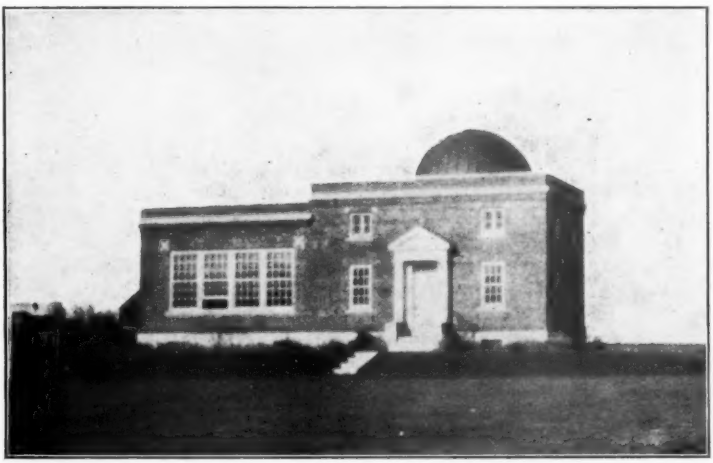
"People attributed shocks felt in their homes to an earthquake, but United States weather bureau officials said that there had been no earth disturbance in

the southern states, and that the tremor was caused by the explosion of the meteor in all probability."

Savannah, Georgia, May 23, 1928.

Observatory at the University of South Carolina.— A new observatory equipped with a 15-inch telescope was formally opened at the University of South Carolina, at Columbia, on May 25. The observatory was presented to the University on this occasion by Edwin G. Seibels, the donor, and the telescope, by J. Wilson Hanshaw, the donor. We shall publish, in the near future, a description of this new observatory.

The Williams Observatory.—Thirty thousand dollars for building and equipping the Williams Observatory were bequeathed to Hood College in Frederick, Maryland, by Miss Janet Williams in 1923 in memory of her father, John H. Williams. Mr. Williams, a business man of Frederick, had loved the stars, continually trying to interest others in them and eagerly reading all the astronomical literature that came to his notice. So his relatives decided that the most



fitting memorial would be an astronomical observatory for students, and Hood College, an outgrowth of the early Frederick Female Seminary, seemed the most suitable legatee. Although some people believed the college had greater needs than for an astronomical observatory, Dr. Joseph Apple, the president, had sufficient vision and appreciation of the value of astronomy in the lives of people to welcome the bequest cordially. He himself taught astronomy in the earlier years of the college and the late A. Thomas G. Apple, professor of astronomy at Franklin Marshall College, was his brother.

Professor Lillian O. Brown of the mathematics department selected the equipment and the Observatory was ready for use in 1925. It has an 8-inch Clark telescope, equatorially mounted, with the usual accessories; a spectroscopic laboratory; a class room equipped for daytime studies; and a flat roof with high brick walls, a convenient place for naked-eye observations.

Miss Leah B. Allen, teaching astronomy at Hood College this year while on leave of absence from Wellesley College, will remain at Hood.

LEAH B. ALLEN.

Zodiacal Light Observations.

From Professor Leah B. Allen, director, Williams Observatory, Hood College, Frederick, Maryland, and Miss Rebecca Jones, assistant at Lick Observatory, reports of observations during April and May have been received. On May 8 at 8:50 P.M., Professor Allen found the light "strikingly bright, extending as a long, narrow triangle, with its base in Auriga, almost to δ Leonis, the central line running several degrees north of Regulus. At 9:15, the light was much fainter. The central line was then seen half way between θ Aurigae and β Tauri, thence to κ Geminorum and κ Leonis."

For April 20 Miss Jones reports that at 9:00 P.M. "the apex was just beyond ϵ Geminorum in line with Pollux. Width at horizon, 20°; width west of galaxy, 10°; width east of galaxy, 5°. The light followed the ecliptic. At midnight the cone had disappeared; only a general blur could be seen near the horizon. During the middle of May the width of the cone at the horizon seemed to be nearer 40° than 20° as the base of the cone merged into the bright horizon."

The apparent greater width of the cone at the horizon just mentioned was studied by Captain Francis J. Bayldon, R.N.R., who attributed this horizon appearance, when the ecliptic is running low, to atmospheric effects. At such times it is well to screen off the horizon when observing the light.

On May 14 at 9:00 P.M. the writer traced the light to a faint apex at Praesepe, and on June 17 at 9:00 P.M. he saw the apex almost due south of Denebola. On each evening the sky was quite clear and seeing conditions were excellent. On March 17 Professor G. Van Biesbroeck secured a splendid photograph of the light at Yerkes Observatory, using a 2-inch Ernostar lens. Time of exposure was 20 minutes. This photograph will be reproduced in POPULAR ASTRONOMY.

During the autumn the morning Zodiacal Light should receive attention and the Gegenschein is best placed for observation from the equinox on through October and November.

LIST OF REFERENCES—III.

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Chant, C. A., *Journal Royal Astr. Society, Canada*, 1907, Vol. I, pp. 12-13.
Wood, H. E., *Transvaal Observatory Circular*, No. 5, 1910. Gegenschein Observations and Drawings.

W. E. GLANVILLE.

The Rectory, New Market, Maryland, 1928 July 9.

International Astronomical Union.—The third congress of the I.A.U., held in Leiden from July 5 to July 13, was unquestionably the most comprehensive and most significant gathering of astronomers in the history of astronomical science. There are twenty-four countries now adhering to the Union. Twenty-seven countries were represented, many of them by a large number of delegates. The list of delegates includes, with a few exceptions, all those who are at present leading in the development of this science.

In every detail of the session the exceptional hospitality of the people of Holland was evident. All members and visitors alike carried away most pleasant memories of a most busy week.

A detailed account of the session will appear in the next issue of this journal.